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MATHEMATICAL MODELING OF SOLID WASTE COLLECTION POLICIES. VOLUME 1 AND 2

Marcus M. Truitt, et al

Johns Hopkins University
Baltimore, Maryland

1970

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MATHEMATICAL MODELING
OF SOLID WASTE COLLECTION POLICIES

Volumes 1 and 2

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I

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II

FOREWORD

THE OBJECTIVE of the Bureau of Solid Waste Management is to aid in developing economic and efficient solid waste management practices. As authorized under the Solid Waste Disposal Act (Public Law 89-272), the Bureau has made almost 100 solid waste research grants to nonprofit institutions in this effort to stimulate and accelerate the development of new or improved ways for handling the Nation's discarded solids. The present document reports on work completed under one of these research grants. Received in two volumes from the grantee, the report is published herein as a single book; other than a new cover, title page, and this foreword, the report is reproduced exactly as received from the grantee.

To predict results of proposed changes in an existing municipal solid wastes collection system, mathematical simulation models were devised by the grantee. Such models, as described in the first volume of this report, would be applicable for comparing costs of collection in other locations. The second volume is a guide that shows how the models can be used as an aid to decision making for solid waste management.

The models were tested successfully by the grantee to predict the results of changes in the study system, thereby verifying promising applicability to other systems. We hope that the mathematical models, as well as the information given on their use, will be helpful to those who must develop, fund, and operate efficient waste collection systems.

--RICHARD D. VAUGHAN, *Director*
Bureau of Solid Waste Management

VOLUME I

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ABSTRACT

Extensive observation was made of refuse collection in urban residential areas in the city of Baltimore and its environs. All data were collected in the context of a classification of four neighborhood types of household densities.

Three models were prepared in FORTRAN IV for simulation of refuse collection systems on an IBM 7094 computer. Data within the models can be easily changed so as to allow other cities' system characteristics to be substituted for the Baltimore data.

Model 1

Model 1 simulated many trucks collecting in an urban neighborhood which had household densities per acre defined within certain limits. Model response of major interest was the number of household units which could be serviced by a collection truck in an eight hour day. Runs were made for different combinations of haul distances, neighborhood densities, collection frequencies, sizes of trucks, and seasons.

Model 2

Model 2 was similar to Model 1 with one major policy difference between the two models: Model 2 policy assigns a definite number of households to

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each truck as the day's task; completion of the task is the operational policy rather than working an eight hour day. Response of major interest is unit cost of the operation for combinations of different collection frequencies, neighborhood types, and haul distances. Sensitivity of response was noted for changes in size of daily task assignment.

Model 3

Model 3 simulates a more complex, more realistic system operating under an assigned task policy in a large urban area of many residential subareas, each definable in one of the four household density classifications.

As initial action, Model 3 calculates the number of daily routes in each subarea; this is a function of subarea neighborhood type, collection frequency, and haul distance. It then assigns trucks by number to subareas by days of the week.

It then simulates collection for a six-day week in the entire area and prints a resume of the week's activities. The model is structured for semiweekly or triweekly collection frequencies, and can simulate a system with or without a transfer station. Different locations for final disposal sites or transfer stations can be cost investigated and so compared.

Many runs were made in this study with the northwest quadrant of Baltimore as the area for which the collection activity was simulated. The response of major interest was always unit cost in dollars per ton for the many combinations of policies and affecting variables.

Specific Results

A refuse collection simulation model, Model 3, was built which has the potential to operate realistically under most system policies and urban environmental conditions. Runs with this model indicated:

1. An increase in collection frequency from semiweekly to triweekly in the northwest quadrant of Baltimore would increase costs approximately $1:00 per ton.
2. In this northwest Baltimore area, eight miles is critical haul distance above which a transfer station is justified.

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CHAPTER I: INTRODUCTION

This work is concerned with mathematical models which simulate the working and operation of residential solid waste collection systems in large congested urban areas. The term "solid waste" here means combined waste, i.e., combustible and non-combustible rubbish and garbage. In particular, interest centers around evaluation of proposed policy changes within a system by use of models rather than evaluation by temporary changes in actual field operations. It is hoped that the models will provide tools in this particular field of environmental engineering which will aid urban decision makers and engineers in wise annual investments of many millions of dollars in years ahead.

From twenty to forty per cent of annual budgets of departments of public works is applied to the tasks of refuse collection and refuse disposal. Of this repetitive expenditure, approximately eighty per cent is consumed in collection, the cost of which has been steadily increasing with no apparent improvement in sanitary quality of service rendered.

So, a problem facing many engineers, city managers, and planners is the formulation of new policies which define the solid waste collection system for the particular city or area for which they have responsibility. Two objectives guide the decisions: the need to create a system which does the job in a manner acceptable to the community, and the necessity of providing service which is economically efficient.

These solid waste collection policies of a city start with decisions made initially by elected representatives of the citizenry. These few major decisions are then expanded by decisions of less importance as details are developed. The prime decision at top level is (1) Is collection to be made by city employees; or (2) Is collection to be made by private firms which contract with the city government; or (3) Is collection to be made by private firms which contract with private citizens. In the United States the arrangements in 995 cities in 1964 is shown in Table I-1 [American Public Works Association, 1966] . Nearly one-half of reporting cities have collection made entirely by city employees, and 65 per cent have complete or partial municipal service. Only 6 per cent of larger cities have ordinances permitting contractual agreements between private citizens and refuse collectors to exclusion of other arrangements.

The extent of collection is an important differentiation between systems. Garbage is defined as the animal and vegetable waste resulting from the preparation, cooking, and serving of foods. Combined refuse is the mixture

Table 1-1

Type of Collection Agency Used in 995 Cities in 1964

	Population in 1000s								
Method	5-10	10-25	25-50	50-100	100-1000	1000 and more	Not Stated	Total	Per Cent
Municipal	116	172	92	34	29	--	3	446	45
Contract	54	70	30	13	7	--	1	175	18
Private	49	43	20	12	3	--	3	130	13
Municipal and Private	15	46	27	22	34	4	3	151	15
Municipal and Contract	1	10	12	8	1	--	1	33	3
Municipal, Contract, Private	3	4	6	1	1	1	--	16	2
Contract and Private	8	14	12	7	3	--	--	44	4
Totals	246	359	199	97	78	5	11	995	100

of garbage and ashes combined with rubbish, which itself is a variety of combustible and noncombustible solid waste from household units, stores, and institutions. If a city government decides to enter the collection business, the next decision is the extent of collection. What classes of waste are to be collected with what frequency? Are all wastes to be mixed together? One policy may require the citizen to wrap garbage for twice a week collection, but may collect other wastes only weekly. An additional limitation of service occurs in cities that deny collection service to certain classes of property. Such limitation is most often applied to commercial establishments, industrial sites, and multiple dwellings. The maximum quantity which will be collected at any one site is specified in many cities. Table I-2 [American Public Works Association, 1966] summarizes practice with regard to class of refuse in the United States.

The elected city officials rather than the city sanitation department may make the major decision of frequency of collection. Present practice tends heavily toward either once per week or twice per week. Table I-3 [American Public Works Association, 1966] gives common practice.

The three major points of policy are: (1) Whether the city will or will not do the collection with its own employees; (2) Assuming this decision is

Table 1-2

Class of Refuse Collected in 1964 by 1,142 Collection Systems Including Municipal, Municipal-Contract, and Private Collectors (in Per Cent)

Class of Refuse Collected	Yes	No
Combined refuse	76.0%	24.0%
Garbage	94.6	5.4
Combustible rubbish	93.1	6.9
Noncombustible rubbish	93.3	6.7
Abandoned automobiles	7.6	92.4
Industrial refuse	34.5	65.5
Contractors' building or demolition wastes	16.9	83.1
Ashes	78.0	22.0
Dead animals	42.5	57.5
Tree debris	35.5	64.5
Bulk refuse	43.0	57.0
Evictions	35.9	64.1

Table 1-3

Frequency of Combined Refuse Collections from Residential and Commercial Areas During the Summer by Municipal Collection Agencies in 1964[1]

Frequency of Collection	Residential	Commercial
(Number of communities responding)	(418)	(359)
Once a week	46.7%	8.1%
Twice a week	48.5	11.4
Three times a week	3.6	3.6
Four times a week	0.0	1.1
Five times a week	0.0	11.7
More than five times a week	0.0	29.3
Fortnightly	0.5	0.0
Monthly	0.0	0.0
Variable	0.7	34.8
Cleanup drives	0.0	0.0
	100.0	100.0

[1] The frequency of collections during the winter varies only slightly from that in the summer.

affirmative, what types of waste are to be collected from whom; (3) With what frequency. With these questions answered, details of equipment, labor, and procedure are normally decided by city managers, city engineers, and other supervisory personnel rather than by elected officials. At this level are financial questions, e.g., pay scales for supervisors, drivers, and laborers, amortization interest rates and times, overtime policy, pension policy, etc.

Engineering aspects include the method of organizing the work. The organizational decision is usually made from two alternatives. These are (1) Each crew is assigned a particular route for each work day of the week. The crew must work until collection is made from all households so assigned. If the work is done before eight hours have passed, the crew is free to leave and yet still receive a full day's pay. If the day's assignment requires more than eight hours to complete, the crew must work overtime. The type of overtime pay arrangement for the last condition varies with cities. This alternative is termed the "definite task" method. (2) The crews work a full eight hour day with many crews' activities being coordinated and directed by a supervisor. The areas worked by any crew will be different from day to day and week to week hopefully in a manner which increases the efficiency of the entire operation. The definite task method has the advantages that the householders know the days of collection, and supervision is easy because of the clear definition of a day's work. Disadvantages include inequalities of lengths of work days between the first collections of the week and subsequent ones; also labor difficulties may develop if different crews collect grossly different daily tonnages. There is the tendency to plan the assigned routes for conditions when work is slowest and most difficult, and this results in the situation that only under these conditions is a full day's work realized.

The preceeding discussion illustrates that the solid waste policy of a major city is broad in the concepts encompassed. Included are types of property serviced, frequency with which the service is conducted, type of equipment and personnel for conducting the operation, pay scales, amortization schedules and all other peripheral decisions which affect the efficiency of the operation. Measurements of economic efficiencies are presented normally as comparisons of cost per ton for similar sanitary qualities of service.

Comparison of costs of solid waste collection systems between two cities is questionable. The appraisal of the dissimilar conditions is difficult, and yet without such appraisal, comparison is not valid. The important differences which must be considered for accurate cost comparison between cities include: (1) climate and geographical differences; (2) form in which the solid waste is presented for collection; (3) frequency of collection; (4) place from which collection is made (curb, alley, back door); (5) average length of haul; (6) wage rates; (7) distribution of population densities; (8) overtime, vacation, and holiday policies; (9) truck depreciation policies.

On the other hand, comparison of costs of solid waste collection between two different operating policies within a city or within a particular part of a city is direct and not subject to differences in many of these variables. For example, a comparison of costs per ton in a particular city between an existing policy of overtime pay versus a proposed policy of overtime pay is a meaningful comparison, direct and uncolored by other system variables.

This study has prepared mathematical simulation models which allow the latter comparison, but not the former. Three models, titled Model 1, Model 2, and Model 3, were so prepared.

All models put collection trucks in the field, all express costs in dollars per ton and record total tonnage collected in some time period. All note average usage of the hours of the work day by the collection trucks, whether in collection activity, in traffic between neighborhood and dumping site, at the disposal site, or in off-route activity, such as truck fueling and cleaning, coffee breaks, and lunch time.

The system variables which can be changed in some or all of the models are:

(1) Household density in households per acre
(2) Haul distance from the neighborhood being collected to the dumping site
(3) Crew size
(4) Size of truck
(5) Season
(6) Collection frequency
(7) Days since past collection
(8) Pay scale for drivers and laborers
(9) Overtime pay policy
(10) Truck amortization and usage charges
(11) Large transport rig amortization and usage charges
(12) Transfer station amortization and usage charges
(13) Distance from transfer station to final disposal site

The three models are discussed individually below:

Model 1, in an individual run, sends several groups of an equal number of trucks of controllable capacity to collect solid waste from neighborhoods of constant density. Each of the groups has haul from collection areas to dumping site over different controllable traffic distances. Collection frequency, pay scales, season, truck charges, and days since last collection are all controllable variables. A sub-routine incorporates the observed or assumed operating characteristics of the city or tract being investigated. These characteristics include histograms, regression equations, and general statements derived from field observations of traffic speeds, collection rates in pounds per hour by different crews operating under different conditions, trucks' time at incinerators or dumping sites, housing units per acre for different neighborhood types, pounds of solid waste generated per person per day, number of people per housing units, etc.

A policy of Model I is to operate trucks and crews for as close to a full eight hour day as is possible. The most important result of this model is the development of a relationship between number of household units per truck and the controllable variables.

Model 2 has the same controllable variables and the same data, but more nearly reflects current practice in that it operates under an "assigned task" policy rather than an "eight-hour day" policy. Model 2, in an individual run, sends a number of groups of trucks of controllable capacity to collect solid waste from neighborhoods of constant controllable density types. Again each of the groups of trucks has a different haul distance from collection area to dumping site. By the proper combination of runs of Model 2, comparison of semiweekly collection costs with triweekly collection costs was made.

Model 3 is a more realistic image of the urban world. It investigates a tract of a large city with different neighborhood densities; it allows change of the location of a transfer station within the tract; it allows the final disposal site to be placed at different distances from the center of the tract and from the location of the transfer station. For different combinations of tract area, distribution of neighborhood densities, location of transfer sites and final disposal sites, the model gives the cost per ton collected in the system being investigated. Thus, Model 3 can be used by any urban area considering most changes in operating policies, whether pay schedules, collection frequencies, or location of or even existence of transfer stations.

Data concerning field operations have been gathered in the City of Baltimore. These data portray to a large extent an urban collection system in the year 1967.

CHAPTER 2: A SURVEY OF PERTINENT LITERATURE

This chapter is divided into two major parts. The first part is a broad survey of publications of the post-World War II years of solid-waste collection practices in America. Little technical reporting on the subject is found prior to 1941 as the matter only became of major interest when the increasing costs incident to it and the blighted urban scene resulting from its inefficient operation finally motivated serious consideration of new technology. The second part of this chapter reviews literature dealing with digital computer simulation. This section also discusses only recent publications, however the recentness of these papers is due to the newness of the digital computer and the subsequently developed techniques of simulation of sets of man's or nature's activities. An important discussion in the second part is of the simulation of a solid waste collection system which was done at Northwestern University [Quon et al., 1965] ; it is the only publication found which combines the two subjects under discussion.

PART I - SOLID WASTE COLLECTION PUBLICATIONS

The definitive American publication on the subject is "Refuse Collection Practice" [American Public Works Association, 1966]; this complete book was first published in 1941, revised in 1958, and again in 1966. It covers current practices, planning, cost estimating, evaluations of innovations in equipment and procedures, and discussion of systems, personnel management, equipment management, and accounting and financing. Typical municipal collection ordinances are included. A large amount of statistical data derived from cities in the United States and Canada of more than 5000 population is presented. These include: (1) Population of reporting cities; (2) Collection system, i.e., whether by municipal employees or by firms contracting with the individual; (3) Extent of service, residential, commercial, and industrial; (4) Collection points, alley, curb, etc.; (5) Frequency of collection; (6) Method of financing; (7) Special services by collecter such as carrying cans to and from the rear doors.

The Sanitary Engineering Research Project of the University of California [1952] published a bulletin which discusses collection operations in detail. It attempts evaluation of the affecting variables which in this reference are termed "influencing factors". It discusses general efficacy of equipment types and presents typical municipal ordinances and an illustrative design of a refuse collection system. The most noticable limitation in this otherwise complete work is that all costs, weights, refuse compositions, labor hours, etc. are limited to California data. The scope of the bulletin is wider than most; the project staff which authored it included specialists from the fields of Sanitary Engineering, Soil Science, Mycology, Microbiology, Hydraulic Engineering, Chemistry, Biochemistry, and Industrial Hygiene.

The American Public Works Association [1964] held a conference on "Solid Waste Research," in December, 1963; the report resulting from this meeting included many papers; a few of those which influenced this study are noted here. Rogus discusses quantities generated and characteristics of urban waste. He attempts to standardize terminology of types of refuse, units of quantity, and characteristic descriptive terms. Also the factors believed most affecting the quantity generated are listed. Various tonnages collected with seasonal patterns from a wide range of sources are given. Bell discusses characteristics of municipal waste as found from a project then current at Purdue University. The results are given from analyzing 2,400 refuse samples from the cities of Milwaukee, Toledo, Indianapolis, and Bloomington, Indiana. Mathematical and statistical parameters were used in the investigation of the data and in the presentation of results. Zanten discusses the existing situation in waste collection, storage, and transportation; and generalizes as to the areas where research would be helpful. Lynn indicates what contributions a system analysis approach may make in the future. The terms, system, mathematical programming, objective function, stochastic, constraints, etc., are carefully presented, defined, and put into a context of an investigation of a solid waste collection system. Examples of the kind of statistical information needed for such a study are given. Possible avenues of such research are illustrated by presenting questions to which answers are needed. Bowerman presents a concise description of an existing transfer station's physical equipment and cost. Future trends in transfer are discussed.

The Ohio Department of Health [1965] held a short course in 1965 titled Technical and Planning Aspects of Solid Wastes. The proceedings from this short course include descriptions of the several methods of collection in use in American cities, and the fundamental criteria for evaluating suitability of the methods by Taylor and by Crane. Lynn describes systems analysis and simulation, optimization, and limitations of the results from such efforts.

In July, 1967, the Engineering Research Conference [1967] sponsored a meeting for the exchange of information, opinions, and ideas between researchers in solid waste. Abstracts of the conference reports were published, and many are being or will be published in their entirety. Hickman reports on composition and per capita generation of residential solid wastes in areas of Cincinnati, evaluating quantity variation within combinations of single family dwellings and apartments with or without food grinders and incinerators. The cyclic character of generation of residential solid wastes and an anlysis of the factors responsible for the effect is reported by Kennedy. Quon concludes that significant changes occurred in quantities of refuse generated in two residential areas as a result of changing collection frequency from once a week to twice a week.

A study of the Los Angeles County solid waste situation is a very complete planning effort [Los Angeles County, 1955]. Definitions of terms are carefully given; factors affecting costs and manpower and machinery requirements are discussed in detail. Conclusions reached include: (l) collection crew size and collection vehicle type do not alter collection manpower requirements significantly; (2) collection vehicles are generally inefficient for haul distances greater than five or six miles; (3) the quantity of waste increased with an increase of frequency of collection; (4) approximately 15 per cent more manpower is required for collection in hilly districts than in level areas; (5) changing collection from once to twice per week requires increasing manpower by 50 per cent. The report includes much information on composition and quantities of solid waste and its seasonal cyclic variation in quantities generated; again this information is limited to the particular locality with which the report deals.

Many valuable thoughts and discussions of attempts to improve collection efficiency have been published in trade magazines rather than in professional journals. These are generally authored by men engaged in the actual task of supervising the collection operation for a city or a region rather than by those whose interests are peripheral in the area. Several are noted here because they have particular applicability to this study. Cole [1960] discusses with enthusiasm the adoption of a transfer station by the city of Lakeland, Florida and the change in collection from a daytime operation to a nighttime one. Karolevitz [1963] plans ahead for the area adjacent to Seattle, Washington incorporating a series of transfer stations and takes into consideration the unique local situation that private citizens deliver about twenty per cent of the total refuse volume. Also complicating the scene are twenty-one licensed commercial haulers operating in the area. He gives costs and savings and plans for the future. Koch [1960] questions the current practice of acquiring disposal sites on a buy-as-needed basis, but in addition he discusses collection haul costs, land costs, equipment costs, and transfer station costs in his particular area of California. King [1960] lists the circumstances which caused Santa Monica to build transfer stations. Among them were increasing costs of the system through the years and the difficulties of their old incinerator system with the Los Angeles Air Pollution Control District. He gives an excellent description of the physical layout of the transfer station and the compacting mechanism adopted.

The review of literature covered decades of isolated tracts dealing with European and New World municipal sanitation. One considered of general interest is "Collection and Disposal of Town Refuse" [Organization for European Economic Cooperation, 1953]. This paper emphasized the relation of the work to general public health. It devoted chapters to European methods of those years. Special processes including transfer stations are described and evaluated. Disposal methods are discussed in detail along with the major problem of collection of household solid waste; the European economic feasibility of recovery of papers, edible foodstuffs, and metals is discussed.

Older references which picture the thinking of the late forties and early fifties include a summary of lectures given at a training course in refuse collecting [University of Michigan, 1947] and a report on Refuse Collection and Disposal Practices [American Public Works Association, 1950].

Thinking in earlier decades on waste collection was generally restricted to nonprofessional personnel, who only rarely put their thoughts and recorded their practices in publications. The problem and its attendent costs are only recently brought to public view.

PART II - DIGITAL COMPUTER SIMULATION

Digital computer simulation is a technique with the objective of giving insight into the behavior of a complex system. A local optimum situation may be found by simulating a system under different conditions and then comparing costs, profits, or operating efficiencies between the results of the simulations. The references cited here are structured and run for a look at an operating system or for the determination of a local optimum value for controllable variables. In all simulations, explicit or implicit constraints are present, whether the objectives are answers to particular questions or merely a succession of snapshots of an operating system.

The peak hour traffic in a bus terminal for the Port of New York Authority has been simulated [Jennings and Dickens, 1958] . The goal is to evaluate the effect of variances in the length of a single lane bus platform. The model generates the number of passengers arriving every minute, the arrival time of buses, and operates on the basis of controllable rules governing the loading of the buses, and entry and exit of buses from assigned berth positions. The model is programmed to give a snapshot of the system at the end of every minute. The results are presented in a manner such that ready evaluation of the influences of platform length on passenger waiting time and bus holding space is possible. This particular paper illustrates a realistic problem of design which did not lend itself to mathematical or direct analytical investigation, but was of such structure that simulation study examined and tested it and gave answers in a form suitable for design utilization, without disruption of service. This paper is particularly valuable for the newcomer to simulation as an introductory reading.

Simulation has been used extensively in war games. More publications seem to be in this area and that of information systems and decision making in the business firm than in all others. The movement of war games from the plotting board, with toy ships, aircraft, troops, maps, and incomplete information for the opposing sides, to simulation on a digital computer was an easy logical step. Computer generated random numbers have replaced throws of dice, and programmed march tables, firing tables, and similar "canned" aids define combat possibilities. A coverage of war games which has had stochastic overtones through the centuries is given in [Griffin, 1965] . He merges basic military gaming with more sophisticated politico - military gaming and in the end, attempts to evaluate the gains and debits for the participants. Other books exist on the subject [Morschaurer, 1962; Schelling, 1960; Zimmerman, 1961.] This last discusses the evolution of a concept of a war gaming model which provides for the codification of many of the decision processes occurring in battle, and once defined, those decisions may be repeated as often as required. There results a mathematical model with all the stochastic variables which directly simulates the step-by-step progress of an isolated battle. This paper specifically attempts to evaluate the effectiveness of a new tank design on the combat effectiveness of company sized units.

Information of broadening interest was found in publications from business administration studies and economic studies. Many were research endeavors taking into account the large number of interactions and interdependencies of communications and decision-making within the firm. Of particular interest are Sprowls and Asimow [1960], Bonini [1963], and Forrester [1961]. Bonini investigates by simulation the effects on the hypothetical firm of three types of changes. These are: (1) changes in the external environment, external in the sense of not being controllable by the firm; (2) changes in the information system of the firm; including the kind of information transmitted, the amount transmitted, and the timing of information flows; and (3) changes in the decision rules. Forrester [1961] describes simulation models which include warehouses, factories, wholesalers, retailers, and consumers. He then "looks at the system" which he has created as preconceived changes in consumer demand, advertising policies, etc., are executed.

Some publications [Maass et al., 1962; Hufschmidt and Fiering, 1966] discuss problems and goals more familiar to civil engineers than the other references which are concerned with business and military affairs. Maass discusses simulation abstractly initially and then the actual simulation model of a river basin system's behavior for flood control, irrigation, and power generation. Limitations of simulation particularly with respect to streamflow and river basin problems are examined. Hufschmidt and Fiering analyze the application of simulation to a planning problem of the Lehigh River basin and its extension to simulation of a larger system, the entire Delaware River basin. The generation of synthetic hydrology is included.

Conway [1963] considers the problem of precision of results obtained from simulation runs and methods of improving them. Effects of starting conditions, effects of sample sizes and replications and the nature of equilibrium in an operating system are examined. Tocher [1965] gives a concise evaluation and indexing of current simulation languages, tabulating for the languages such pertinent aspects as the basic language from which the simulation language is derived, the computer for which the language is suited, the sampling procedures available in each, the naming of variables in each, etc. Tocher [1963] deals generally with the study of industrial operations and processes by simulation. Sampling from distributions, sampling methods, random number generation techniques, and queuing problems are covered.

The original work which applies digital computer simulation to municipal solid waste collection is by Quon [1965]. This has as a major objective the delineation of interrelations between the affecting variables on the functioning of the system. The data upon which the system operation were based were from the solid waste operations of the village of Winnetka, Illinois. Haul efficiency and over-all efficiencies are measured in units of man-minutes per ton rather than in units of dollars per ton. Sensitivity measurements are made for varying coefficients of variation of the quantity of solid waste generated per service per week.

CHAPTER 3: THE POLICIES AND STRUCTURES OF MODELS I AND 2

The purpose of Model I is the determination of the collection potential and associated costs of a collection truck operating under a set of stochastic conditions within the framework of an eight hour work day. Because of stochastic influences, a single run of a truck is not indicative of the performance which can be expected. Therefore Model I fields thirty trucks at a time, operating under the same stochastic influences and under the environmental conditions desired by the investigator. The results of major interest from this model are the mean, the maximum, the minimum, and the standard deviation of the number of household units from which collection was made by these thirty trucks in one day under the particular conditions of season, neighborhood type, haul distance, etc.

The purpose of Model 2 is the determination of results of assigning a definite number of household units for collection to a truck for its task for a day. Again because of stochastic conditions, a single run of a truck is not conclusive, and so thirty trucks are fielded under constant environmental conditions. The Model I runs necessarily preceded those of Model 2 as the decisions for the number of household units to be assigned in the latter model were based on the number serviced in the former. The results of greatest interest from Model 2 are the unit costs of collection in dollars per ton for different conditions, particularly different collection frequencies and different sizes of daily task assignments for the 20 cubic yard collection trucks.

The information obtained from Models 1 and 2 influenced the aims and structuring of Model 3.

POLICIES OF MODEL 1

The model simulated the fielding of 180 collection trucks for the purpose of collection of solid waste. Each run has a constant neighborhood density for all 180 trucks; other variables held constant for individual runs are number of days since last collection, collection frequency per week, season, truck capacity, and size of crew. On each run, Model 1 was programmed so that of the 180 trucks "working", groups of thirty each were sent to six different collection areas, each area being a different distance from the final disposal site. These six different haul distances were: one, four, eight, twelve, eighteen, and twenty-four miles. Table 3-3 shows the printout of results for one of the groups of 30 trucks.

The number of haul distances and the number of trucks dispatched to each can be changed to any values respectively between one and ten, and between 180 and eighteen; the constraint being that the product of the number of trucks times the number of distances cannot exceed 180. Thus, if an investigator wishes, he may send ninety trucks to each of two neighborhoods to work under the policies of Model 1, with all factors constant for both sets excepting the two different haul distances. The results of the run would be a comparison of costs between two alternative disposal sites at the different distances.

In this study, a total of 24 runs was made with Model 1. In these different runs, seasons, number of days since last collection, collection frequency, and other controllable variables were varied as shown in Table 3-1.

All time spent by a crew during the day was assigned to one of four categories: (1) Traffic time between the disposal site and beginning of collection, and between ending of collection and arrival at disposal site, excepting flat tires and breakdowns; (2) Collection time, calculated by:

$$Tc = \text{Wt Col}/\text{Col Rate}$$

in which Wt Col = Truck's net loaded rate

randomly generated from a histogram of Baltimore data

for the particular capacity truck,

TABLE 3-1

MODEL 1 RUNS

Run no.	Type truck[a]	Days since last collection	Neighborhood type	Season[a]	Collection frequency per week	Size of crew
1	1	4	1	1	2	4
2	1	4	2	1	2	4
3	1	4	3	1	2	4
4	1	4	4	1	2	4
5	2	4	2	1	2	4
6	2	4	2	1	2	4
7	2	4	3	1	2	4
8	2	4	4	1	2	4
9	1	3	1	1	2	3
10	1	3	2	1	2	3
11	1	3	3	1	2	3
12	1	3	4	1	2	3
13	2	3	1	1	2	3
14	2	3	2	1	2	3
15	2	3	3	1	2	3
16	2	3	4	1	2	3
25	1	3	1	2	2	3
26	1	4	1	2	2	4
27	1	3	4	2	2	3
28	1	4	4	2	2	4
29	2	3	1	2	2	3
30	2	4	1	2	2	4
31	2	3	4	2	2	3
32	2	4	4	2	2	4

[a] Truck type 1 is a 13 cubic yard truck
Truck type 2 is a 20 cubic yard truck

[a] Season type 1 is summer
Season type 2 is winter

and Col Rate Collection rate in pounds per hour
randomly generated from a histogram of Baltimore data
for the particular crew size under the run's conditions
of days since last collection, etc.

(3) Incinerator time, in minutes, randomly generated from a histogram of truck times at the two Baltimore incinerators; (4) Off-route time, which included the following: (a) Some time between 50 minutes and 68 minutes, reflecting two twenty-five minute breaks during the day plus the assumption that the 180 trucks left the main garage at 0.1 minute intervals in the morning. (b) Breakdown time; breakdowns were generated at random; when they occurred, the truck was charged with twenty-five minutes of off-route time. (c) In the prototype activities at garages, it was noted that servicing of the trucks was normally done at the end of the day for the following day. Also if the crew finished particularly early, the truck was cleaned by hosing and some minor repairs were made. The model has the following policies: If truck and crew have already worked eight hours after dumping, no off-route time is logged by the truck, i.e., no servicing or cleaning. If clocktime after dumping is within one hour of a full eight-hour day, one-half of the remaining work time is logged to off-route time and the crew is freed the other one-half.

After each dumping of a load by an individual truck, a check is made of the probability that the truck can, without going on overtime, return to its collection area with an expected thirty minutes available for collection work, and then return in traffic and dump. This determines whether another load is collected.

A proper combination of random events puts individual trucks on overtime. A truck can have a flat tire or minor breakdown while on overtime and so log this off-route time; however, no additional off-route time for coffee breaks or truck servicing at end of day is used by an overtime truck.

Model 1 is based on the plan that the trucks work a full eight-hour day collecting from as many household units as possible. As the day passes, the decisions of greatest importance are: (1) after dumping, should another collection trip be made; and (2) on arrival at the collection area, does time remain to collect a full load or only a partial load. All decisions are programmed for the intended completion of the day's work without overtime.

Regular and overtime pay scales, truck maintenance and operation costs, and amortization rates can each be changed by a single card in the Block Data subroutine to fit the financial picture of any city. However, the model is programmed to the policy that overtime pay is paid to the next integer hour, as this is current practice in Baltimore.

Figures 3-3, 3-4, 3-5, and 3-7 show flow-charts for the principal subroutines of Model 1.

POLICIES OF MODEL 2

This model is in essence Model 1 with a single major policy change. Model 2 has given to each of its 180 trucks a definite task assignment of some number of household units from which to collect. This task is to be done regardless of the shortness of workday or overtime necessary for its completion. No decision-making is programmed in Model 2 to determine if another trip shall be made or if time permits another full load or a partial load. The only question asked for each truck is if all assigned units have been serviced. The classifications of elapsed time for the individual trucks are the same as in Model 1.

In this study a total of 34 runs were made with Model 2. In these different runs, the controllable variables were given values as shown in Table 3-2. The Collection subroutine and the Cinera subroutine are different for the two models; Model 2 flow charts for these subroutines are shown in Figures 3-6 and 3-8.

TABLE 3-2

MODEL 2 RUNS

Run	Days since last collection	Neighborhood type	Collection frequency	Size of crew
17	3	1	3	3
18	3	2	3	3
19	3	3	3	3
20	3	4	3	3
21	2	1	3	3
22	2	2	3	3
23	2	3	3	3
24	2	4	3	3
33	4	1	2	4
34	4	2	2	4
35	4	3	2	4
36	4	4	2	4
37	3	1	2	3
38	3	2	2	3
39	3	3	2	3
40	3	4	2	3
22-2	2	2	3	3
22-3	2	2	3	3
51	4	2	2	4
52	4	2	2	4
53	4	2	2	4
55	4	3	2	4
56	4	3	2	4
57	4	3	2	4
71	3	2	2	3
72	3	2	2	3
73	3	2	2	3
75	3	3	2	3
76	3	3	2	3
77	3	3	2	3
81	4	1	2	4
82	3	1	2	3
83	4	1	2	4
84	3	1	2	3

All runs are with 20 yard trucks in summer season.

STRUCTURE OF MODELS I AND 2

The programs of these models depend heavily on a list processing program prepared by Dr. Mandell Bellmore of the Johns Hopkins University. This program served as a core with prototype activities tied about it. Figure 3-I shows the general schematic of Models I and 2 while Figure 3-2 shows a more detailed interaction of the Main program with the 33 subroutines. A discussion follows concerning individual subroutines positioned in the blocks of Figure 3-I.

MAIN PROGRAM

Two dictionaries are listed at the beginning of the main program, one of list processing variables and one of simulation model variables. This program acts as the focal point out of which the Initialization group of subroutines, the List Processing group of subroutines, and the Result group of subroutines are called.

INITIALIZATION SUBROUTINES

(I) BLOCK DATA: Here in one package are the observed or assumed attributes of the city or tract being investigated; included are the costs

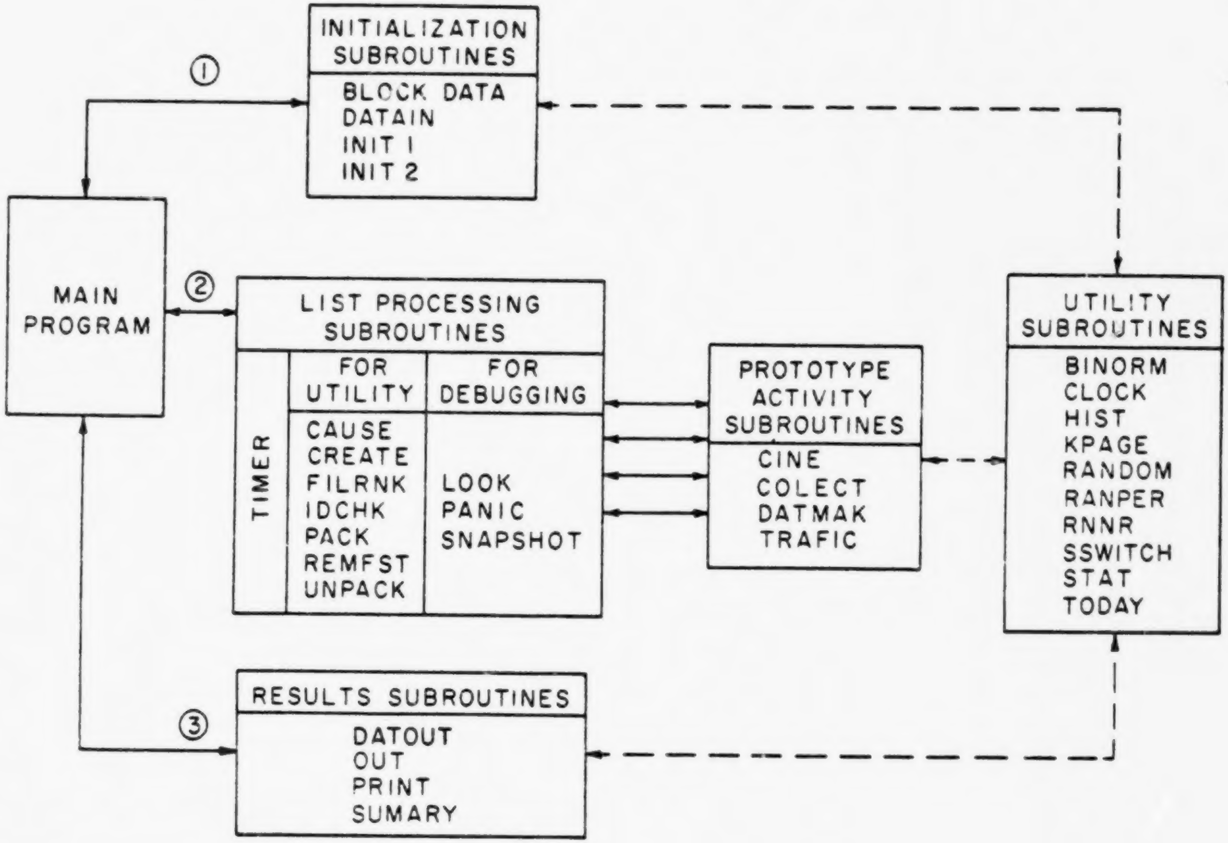

MAIN PROGRAM
①
②
③
INITIALIZATION SUBROUTINES
BLOCK DATA
DATAIN
INIT 1
INIT 2
LIST PROCESSING SUBROUTINES
TIMER
FOR UTILITY
CAUSE
CREATE
FILRNK
IDCHK
PACK
REMFST
UNPACK
FOR DEBUGGING
LOOK
PANIC
SNAPSHOT
PROTOTYPE ACTIVITY SUBROUTINES
CINE
COLECT
DATMAK
TRAFIC
UTILITY SUBROUTINES
BINORM
CLOCK
HIST
KPAGE
RANDOM
RANPER
RNNR
SSWITCH
STAT
TODAY
RESULTS SUBROUTINES
DATOUT
OUT
PRINT
SUMARY

FIGURE 3 - 1

General Schematic of Models 1 and 2

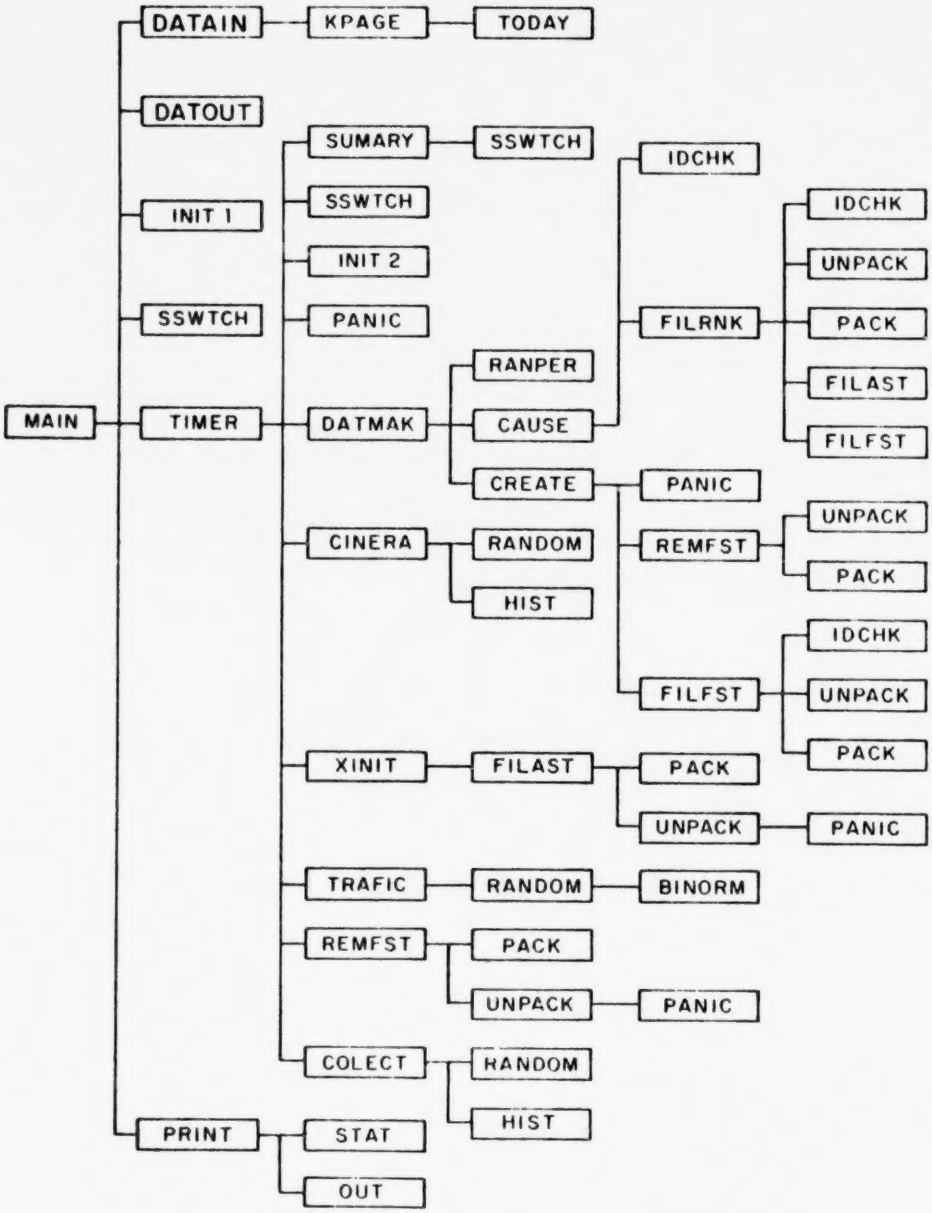

MAIN
DATAIN
KPAGE
TODAY
DATOUT
SUMARY
SSWTCH
INIT 1
SSWTCH
INIT 2
SSWTCH
PANIC
TIMER
DATMAK
RANPER
CAUSE
IDCHK
FILRNK
IDCHK
UNPACK
PACK
FILAST
FILFST
CREATE
PANIC
REMFST
UNPACK
PACK
FILFST
IDCHK
UNPACK
PACK
CINERA
RANDOM
HIST
XINIT
FILAST
PACK
UNPACK
PANIC
TRAFIC
RANDOM
BINORM
REMFST
PACK
UNPACK
PANIC
COLECT
RANDOM
HIST
PRINT
STAT
OUT

FIGURE 3 - 2

Interaction of Subroutines

of labor and equipment, and the many data which describe the neighborhood densities, collection rates, loaded weights of trucks, histograms of incinerator waiting times, regression equation parameters of relation between traffic speeds on trip distances, season constants, waste weights generated per capita, etc. This mass of city or tract attributes coupled with the values of the run variables of the DATAIN subroutine coupled with the decision between Model 1 policy or Model 2 policy encompass the control possible by the investigator. Studies which desire other variables or policies necessitate changes in programming.

(2) DATAIN: The run variables are given values here. These include:

(a) the run number

(b) the control parameter, K, for starting the random number generator. When K is set equal to zero, the values of the numbers generated are unpredictable and vary with each succeeding run. When K is set equal to a positive integer, the sequence of the generated random numbers will be the same for successive runs.

(c) the type of truck; Models 1 and 2 are programmed for two sizes of collection trucks.

(d) the number of days since last collection; values can be three or four.

(e) the neighborhood type; four values reflecting population density are used.

(f) the season; summer or winter.

(g) the collection frequency; semiweekly or triweekly.

(h) the crew size; three or four men.

(3) INITZ: Initializes to zero the accumulators, counters, and entity attributes in the simulation subroutines.

LIST PROCESSING SUBROUTINES

(1) TIMER: acts with the aid of its utility subroutines as clock or time base for the events which occur within the simulation model. Its actual operation is to remove the first ranking event from the calendar of events, note the type of event, and so to direct model activity properly.

(2) CAUSE: places event notices generated by prototype activities on the calendar.

(3) CREATE: used only once on each run to create the initial calendar.

(4) FILFST, FILLST, FILRNK: file events at first of list, last of list, or

in a ranked position, as desired. The list is the calendar in the case of the CAUSE subroutine.

(5) IDCHK: a precautionary subroutine which checks the validity of list number called.

(6) PACK: combines individual numbers which describe attributes of an event into a single number; its purpose is to save computer effort and memory space.

(7) REMFST: removes events from the calendar from the first of list. In Models I and 2, events were filed in a ranked manner so that the first in the list was that one which was always next to be removed.

(8) UNPACK: separates the single packed number described in PACK into its components.

(9) LOOK: allows an interruption to the system's operation for the purpose of viewing the condition of a specified list (calendar).

(10) PANIC: if an unacceptable condition has occurred in the TIMER, IDCHK, or UNPACK subroutines, PANIC is called to identify the current

event and its attributes and to terminate processing.

(11) SNPSHT: prints the event and its attributes for which the LOOK subroutine is called.

RESULT SUBROUTINES

(1) DATOUT: prints the controllable run variables which were supplied by DATAIN subroutine.

(2) OUT: prints the results of the run with alphameric explanations.

(3) PRINT: prints alphameric description of the run, the values of the run variables, and calls STAT and OUT subroutines.

(4) SUMARY: when trucks have finished their day's work, this subroutine performs calculations to reduce information to more usable form.

PROTOTYPE ACTIVITY SUBROUTINES

(1) CINE: contains decision policies, the counters, and recording commands used while the truck is at disposal site. Decision is made here to return

or not for another load in case of Model 1, and whether or not all units are serviced in case of Model 2. A counter notes in both models when all trucks are done for the day.

(2) COLECT: contains collection decision policies, accumulators and counters for weights, times, acres serviced, units serviced, and reference commands to pertinent system attribute histograms for those times when the trucks are engaged in neighborhood waste collection.

(3) DATMAK: after the 180 trucks of these two models are assigned random initial departure times within controllable limits, this subroutine assigns proper haul distances to the trucks, does the necessary calculations to give initial values other than zero to the attributes of next event time, off-route time, and type of event, and calls CREATE and CAUSE so that this information may be placed on the calendar.

(4) TRAFIC: records the individual truck's time in traffic, both to and from the collection area. Possibility of flat tires and breakdown is included.

UTILITY SUBROUTINES

(1) BINORM: allows random values to be generated from a normal distribution.

(2) CLOCK: used once only to obtain the exact time which starts the random number generator to insure an independent sequence.

(3) HIST: by first generating a random number and then entering the accumulative plot of a called histogram, this subroutine takes a value from the range of values covered by the histogram.

(4) KPAGE: prints page titles and page numbers.

(5) RANDOM: in combination with BINORM, allows random values to be generated from a normal distribution with a mean and a standard deviation which are designated by the user.

(6) RANPER: generates a random permutation of the first N integers.

(7) RNNR: generates a random number from a rectangular distribution with values between zero and unity.

(8) SSWTCH: allows the operator to interrupt during execution from the computer console.

(9) STAT: makes the calculations to reduce the attributes of 180 trucks to their individual means and standard deviations. The maximum and

minimum of each attribute are found by search.

(10) TODAY: obtains the current date for printing by KPAGE for run identification.

Flow charts of the prototype activities follow, illustrating the policies and logic of Models 1 and 2.

Figure 3-3 illustrates DATMAK for both models.

Figure 3-4 illustrates TRAFIC for both models.

Figure 3-5 illustrates COLECT for Model 1.

Figure 3-6 illustrates COLECT for Model 2.

Figure 3-7 illustrates CINERA for Model 1.

Figure 3-8 illustrates CINERA for Model 2.

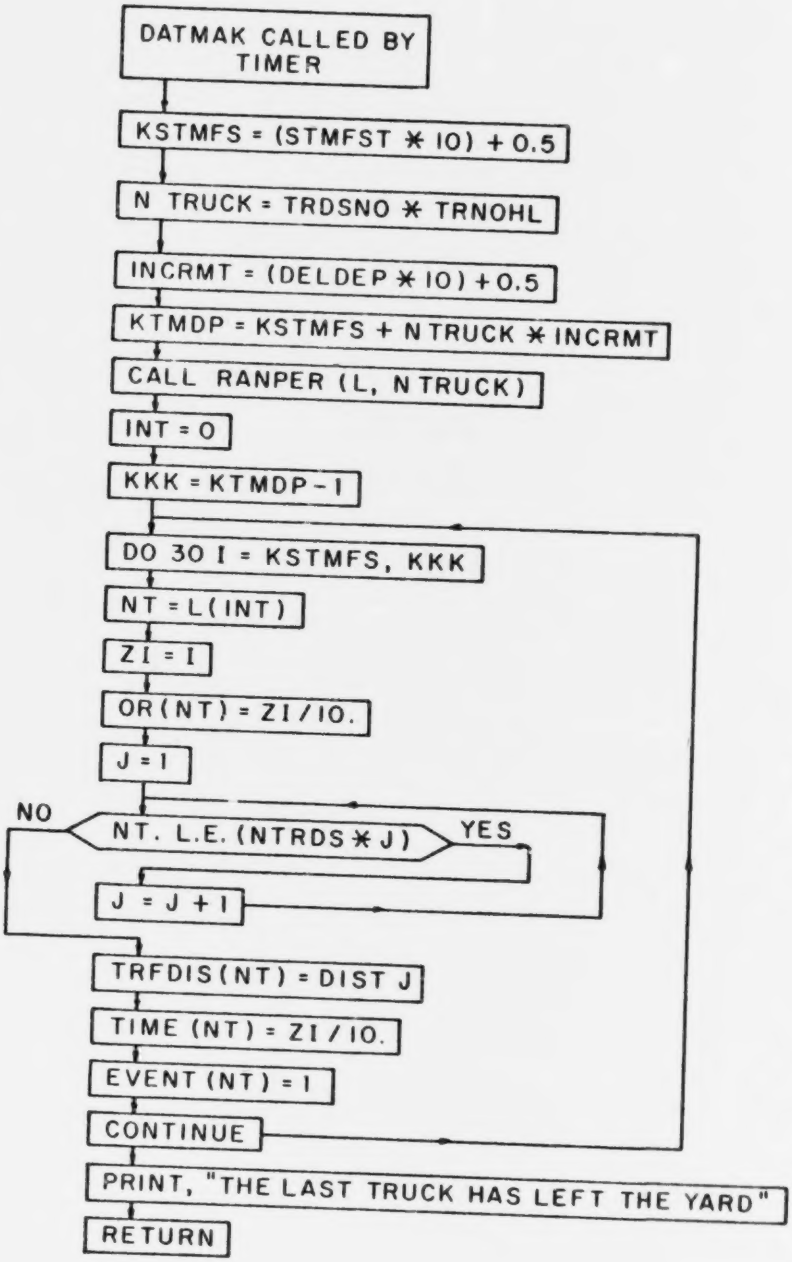

DATMAK CALLED BY TIMER
KSTMFS = (STMFST * 10) + 0.5
N TRUCK = TRDSNO * TRNOHL
INCRMT = (DELDEP * 10) + 0.5
KTMDP = KSTMFS + N TRUCK * INCRMT
CALL RANPER (L, N TRUCK)
INT = 0
KKK = KTMDP - 1
DO 30 I = KSTMFS, KKK
NT = L(INT)
ZI = I
OR(NT) = ZI/10.
J = 1
NO
NT. L.E. (NTRDS * J)
YES
J = J + 1
TRFDIS(NT) = DIST J
TIME (NT) = ZI/10.
EVENT (NT) = 1
CONTINUE
PRINT, "THE LAST TRUCK HAS LEFT THE YARD"
RETURN

FIGURE 3 - 3

Subroutine DATMAK, Models 1 and 2

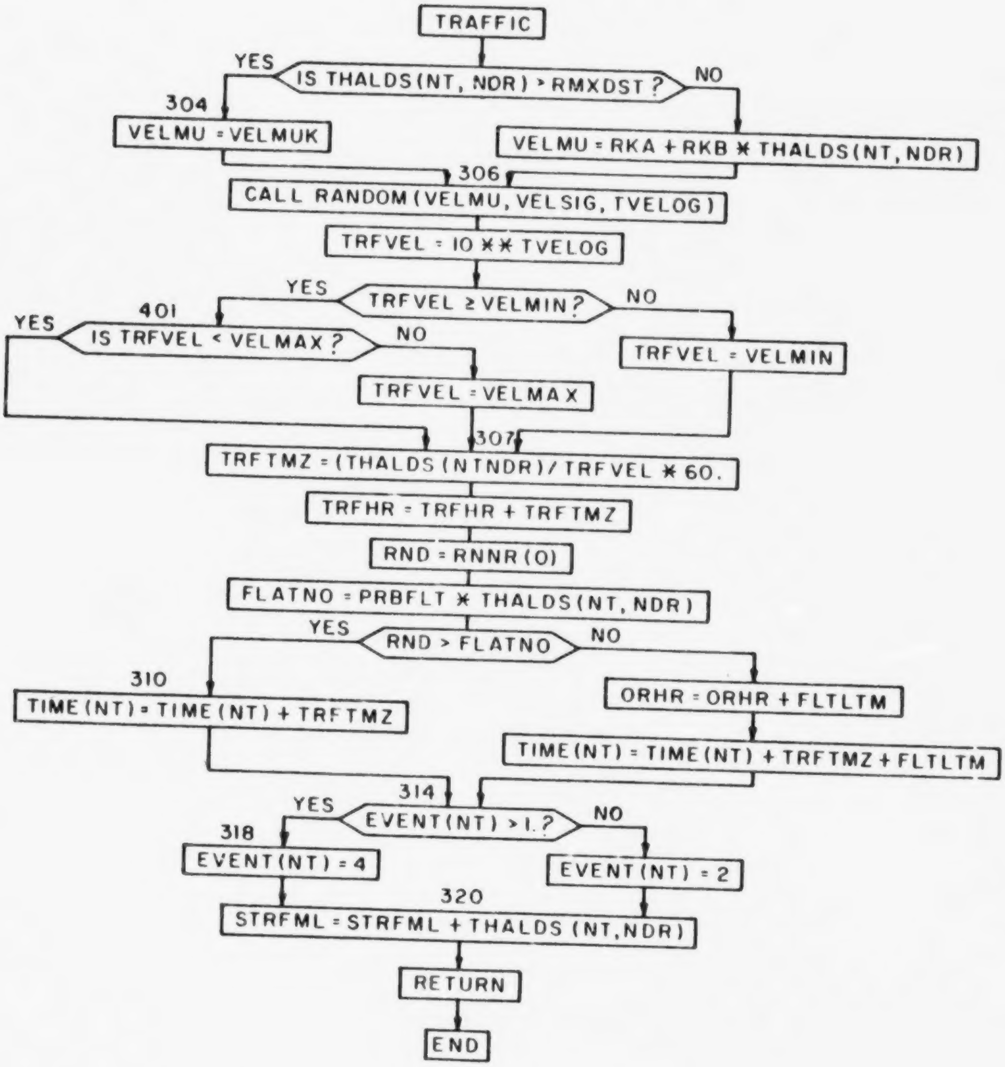

TRAFFIC
YES
IS THALDS(NT, NDR) > RMXDST ?
NO
304
VELMU = VELMUK
VELMU = RKA + RKB ✱ THALDS(NT, NDR)
306
CALL RANDOM (VELMU, VELSIG, TVELOG)
TRFVEL = 10 ✱✱ TVELOG
YES
TRFVEL ≥ VELMIN ?
NO
401
YES
IS TRFVEL < VELMAX ?
NO
TRFVEL = VELMIN
TRFVEL = VELMAX
307
TRFTMZ = (THALDS (NTNDR) / TRFVEL ✱ 60.
TRFHR = TRFHR + TRFTMZ
RND = RNNR (0)
FLATNO = PRBFLT ✱ THALDS (NT, NDR)
YES
RND > FLATNO
NO
310
TIME (NT) = TIME (NT) + TRFTMZ
ORHR = ORHR + FLTLTM
TIME (NT) = TIME (NT) + TRFTMZ + FLTLTM
314
YES
EVENT (NT) > 1. ?
NO
318
EVENT (NT) = 4
EVENT (NT) = 2
320
STRFML = STRFML + THALDS (NT,NDR)
RETURN
END

FIGURE 3 - 4

Subroutine TRAFIC, Models 1 and 2

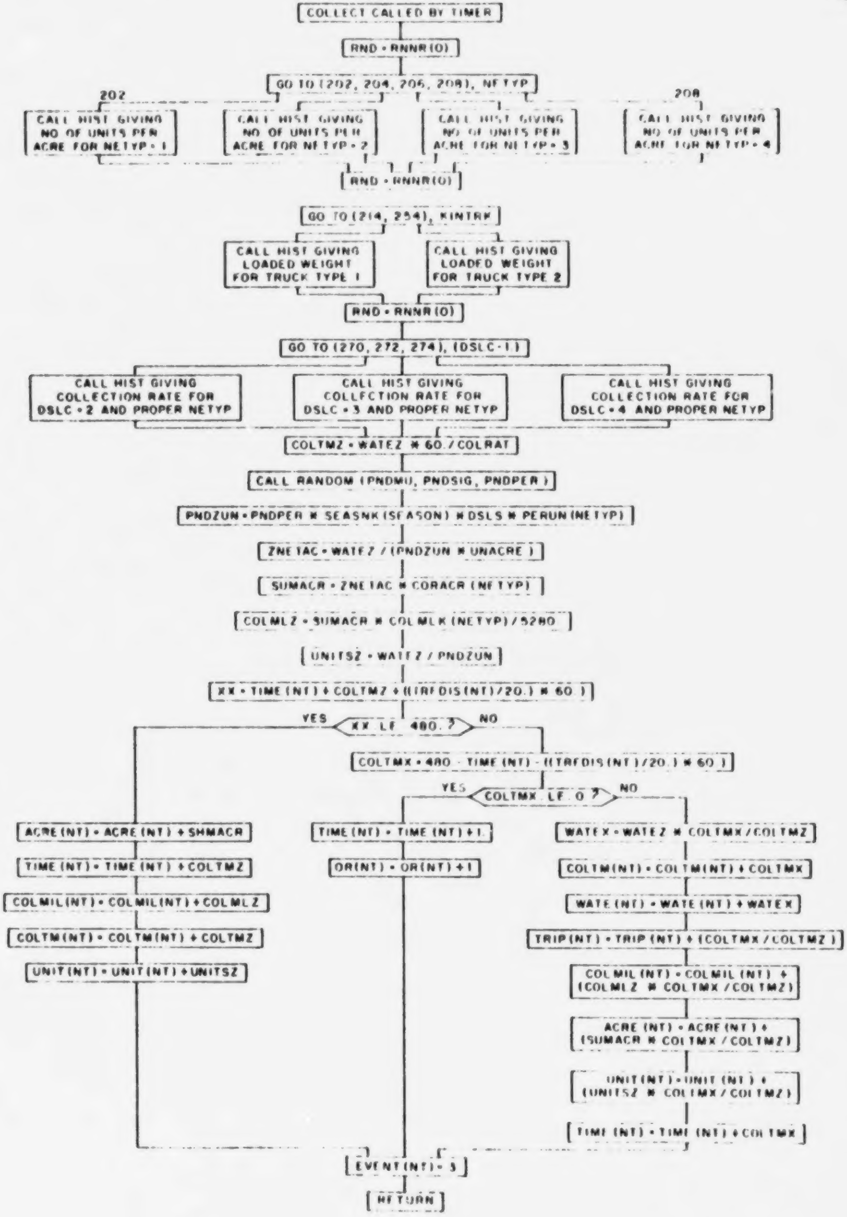

COLLECT CALLED BY TIMER
RND = RNNR(0)
GO TO (202, 204, 206, 208), NETYP
202
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 1
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 2
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 3
208
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 4
RND = RNNR(0)
GO TO (214, 254), KINTRK
CALL HIST GIVING LOADED WEIGHT FOR TRUCK TYPE 1
CALL HIST GIVING LOADED WEIGHT FOR TRUCK TYPE 2
RND = RNNR(0)
GO TO (270, 272, 274), (DSLC-1)
CALL HIST GIVING COLLECTION RATE FOR DSLC = 2 AND PROPER NETYP
CALL HIST GIVING COLLECTION RATE FOR DSLC = 3 AND PROPER NETYP
CALL HIST GIVING COLLECTION RATE FOR DSLC = 4 AND PROPER NETYP
COLTMZ = WATEZ * 60./COLRAT
CALL RANDOM (PNDMU, PNDSIG, PNDPER)
PNDZUN = PNDPER * SEASNK(SEASON) * DSLS * PERUN(NETYP)
ZNETAC = WATEZ / (PNDZUN * UNACRE)
SUMACR = ZNETAC * CORACR (NETYP)
COLMLZ = SUMACR * COLMLK (NETYP) / 5280
UNITSZ = WATEZ / PNDZUN
XX = TIME (NT) + COLTMZ + ((TRFDIS(NT)/20.) * 60.)
YES
XX .LE. 480. ?
NO
COLTMX = 480 - TIME (NT) - ((TRFDIS(NT)/20.) * 60.)
YES
COLTMX .LE. 0 ?
NO
ACRE(NT) = ACRE(NT) + SUMACR
TIME(NT) = TIME(NT) + COLTMZ
COLMIL(NT) = COLMIL(NT) + COLMLZ
COLTM(NT) = COLTM(NT) + COLTMZ
UNIT(NT) = UNIT(NT) + UNITSZ
TIME(NT) = TIME(NT) + 1.
OR(NT) = OR(NT) + 1
WATEX = WATEZ * COLTMX/COLTMZ
COLTM(NT) = COLTM(NT) + COLTMX
WATE(NT) = WATE(NT) + WATEX
TRIP(NT) = TRIP(NT) + (COLTMX / COLTMZ)
COLMIL(NT) = COLMIL(NT) + (COLMLZ * COLTMX / COLTMZ)
ACRE(NT) = ACRE(NT) + (SUMACR * COLTMX / COLTMZ)
UNIT(NT) = UNIT(NT) + (UNITSZ * COLTMX / COLTMZ)
TIME(NT) = TIME(NT) + COLTMX
EVENT(NT) = 3
RETURN

FIGURE 3 - 5

Subroutine COLECT, Model 1

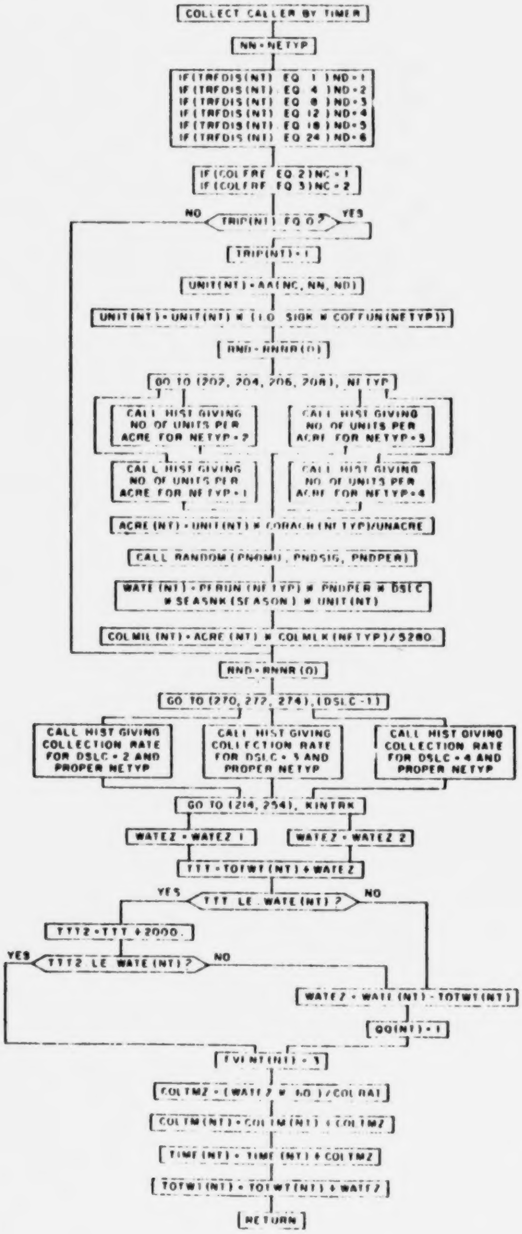

COLLECT CALLER BY TIMER
NN = NETYP
IF(TRFDIS(NT) EQ 1)ND = 1
IF(TRFDIS(NT) EQ 4)ND = 2
IF(TRFDIS(NT) EQ 8)ND = 3
IF(TRFDIS(NT) EQ 12)ND = 4
IF(TRFDIS(NT) EQ 18)ND = 5
IF(TRFDIS(NT) EQ 24)ND = 6
IF(COLFRE EQ 2)NC = 1
IF(COLFRE EQ 3)NC = 2
NO
TRIP(NT) EQ 0?
YES
TRIP(NT) = 1
UNIT(NT) = AA(NC, NN, ND)
UNIT(NT) = UNIT(NT) * (1.0 SIGK * COFFUN(NETYP))
RND = RNNR(0)
GO TO (202, 204, 206, 208), NETYP
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 2
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 3
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 1
CALL HIST GIVING NO OF UNITS PER ACRE FOR NETYP = 4
ACRE(NT) = UNIT(NT) * CORACH(NETYP)/UNACRE
CALL RANDOM(PNOMU, PNDSIG, PNDPER)
WATE(NT) = PERUN(NETYP) * PNDPER * DSLC * SEASNK(SEASON) * UNIT(NT)
COLMIL(NT) = ACRE(NT) * COLMLK(NETYP)/5280
RND = RNNR(0)
GO TO (270, 272, 274),(DSLC-1)
CALL HIST GIVING COLLECTION RATE FOR DSLC = 2 AND PROPER NETYP
CALL HIST GIVING COLLECTION RATE FOR DSLC = 3 AND PROPER NETYP
CALL HIST GIVING COLLECTION RATE FOR DSLC = 4 AND PROPER NETYP
GO TO (214, 254), KINTRK
WATEZ = WATEZ 1
WATEZ = WATEZ 2
TTT = TOTWT(NT) + WATEZ
YES
TTT LE. WATE(NT)?
NO
TTT2 = TTT + 2000.
YES
TTT2 LE WATE(NT)?
NO
WATEZ = WATE(NT) - TOTWT(NT)
QQ(NT) = 1
EVENT(NT) = 3
COLTMZ = (WATEZ * 60)/COLRAT
COLTM(NT) = COLTM(NT) + COLTMZ
TIME(NT) = TIME(NT) + COLTMZ
TOTWT(NT) = TOTWT(NT) + WATEZ
RETURN

FIGURE 3 - 6

Subroutine COLECT, Model 2

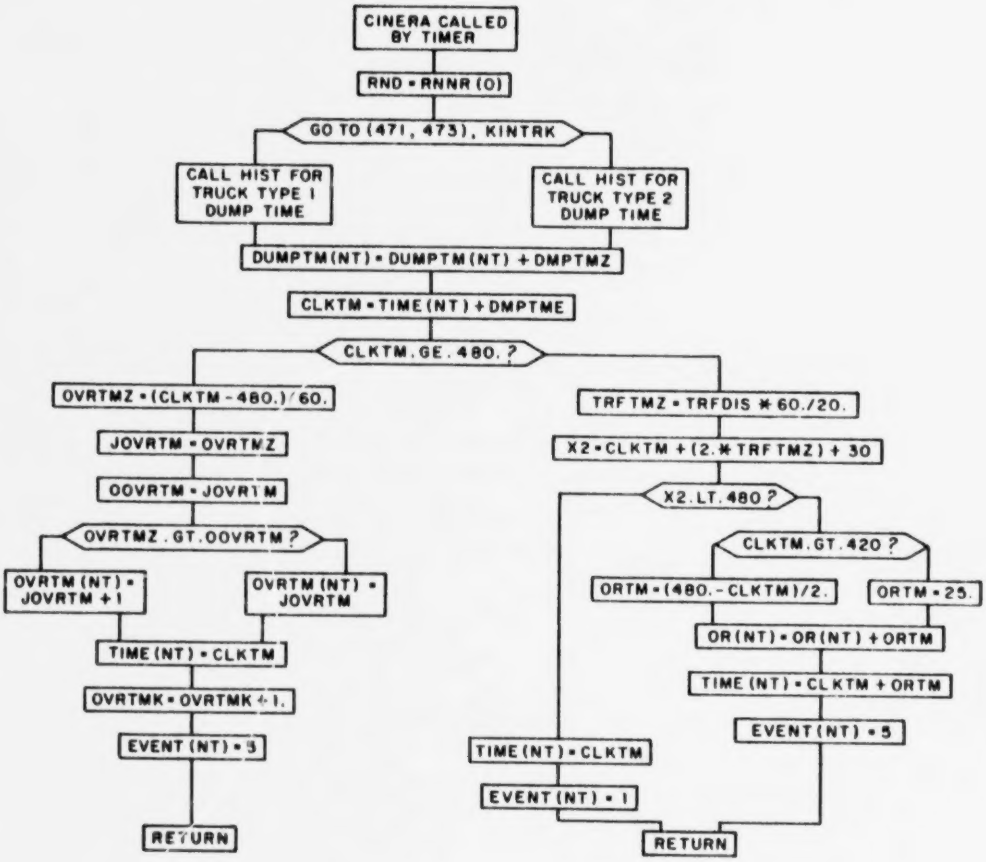

CINERA CALLED BY TIMER
RND = RNNR (0)
GO TO (471, 473), KINTRK
CALL HIST FOR TRUCK TYPE 1 DUMP TIME
CALL HIST FOR TRUCK TYPE 2 DUMP TIME
DUMPTM(NT) = DUMPTM(NT) + DMPTMZ
CLKTM = TIME(NT) + DMPTME
CLKTM.GE.480.?
OVRTMZ = (CLKTM - 480.)/60.
JOVRTM = OVRTMZ
OOVRTM = JOVRTM
OVRTMZ.GT.OOVRTM?
OVRTM(NT) = JOVRTM + 1
OVRTM(NT) = JOVRTM
TIME(NT) = CLKTM
OVRTMK = OVRTMK + 1.
EVENT(NT) = 5
RETURN
TRFTMZ = TRFDIS * 60./20.
X2 = CLKTM + (2. * TRFTMZ) + 30
X2.LT.480?
CLKTM.GT.420?
ORTM = (480. - CLKTM)/2.
ORTM = 25.
OR(NT) = OR(NT) + ORTM
TIME(NT) = CLKTM + ORTM
EVENT(NT) = 5
TIME(NT) = CLKTM
EVENT(NT) = 1
RETURN

FIGURE 3 - 7

Subroutine CINERA, Model 1

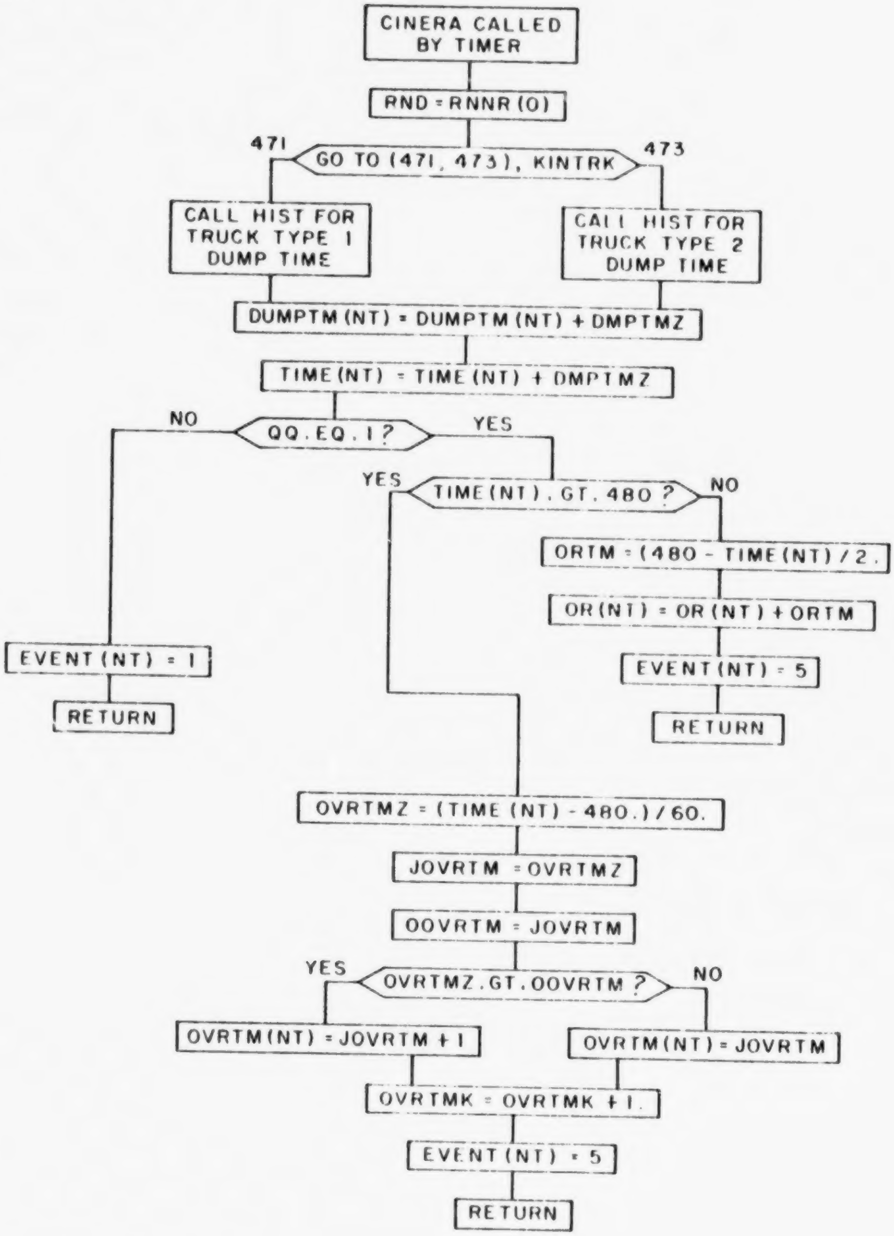

CINERA CALLED BY TIMER
RND = RNNR (0)
471
GO TO (471, 473), KINTRK
473
CALL HIST FOR TRUCK TYPE 1 DUMP TIME
CALL HIST FOR TRUCK TYPE 2 DUMP TIME
DUMPTM (NT) = DUMPTM (NT) + DMPTMZ
TIME (NT) = TIME (NT) + DMPTMZ
NO
QQ.EQ.1?
YES
YES
TIME (NT). GT. 480 ?
NO
ORTM = (480 - TIME (NT) / 2.
OR (NT) = OR (NT) + ORTM
EVENT (NT) = 1
RETURN
EVENT (NT) = 5
RETURN
OVRTMZ = (TIME (NT) - 480.) / 60.
JOVRTM = OVRTMZ
OOVRTM = JOVRTM
YES
OVRTMZ.GT.OOVRTM ?
NO
OVRTM (NT) = JOVRTM + 1
OVRTM (NT) = JOVRTM
OVRTMK = OVRTMK + 1.
EVENT (NT) = 5
RETURN

FIGURE 3 - 8

Subroutine CINERA, Model 2

TABLE 3-3

A PART OF THE PRINT-OUT OF RESULTS FROM A RUN OF MODEL 2

	Average	Sigma	Maximum	Minimum
Tonnage Collected	9.13	0.39	9.88	8.45
Gross acres covered	189.46	76.68	416.29	105.69
Housing unit collected	812.00	0.	812.00	812.00
Number of trips	2.03	0.18	3.00	2.00
Quitting time, hours of work	7.83	1.30	11.45	6.09
Traffic miles	48.80	4.38	72.00	48.00
Collection miles	19.74	7.99	43.36	11.01
Percent time collecting	54.81	13.19	76.99	28.73
Percent time in traffic	20.87	4.74	40.27	12.50
Percent time in dumping	2.55	1.08	5.58	1.22
Percent time off route	21.77	10.25	45.23	7.48
Collection cost per gross acre	0.39	0.20	0.96	0.12
Total cost per gross acre	0.69	0.24	1.24	0.25
Haul cost per ton	2.61	0.47	4.34	1.88
Collection cost per ton	7.22	2.95	14.62	3.11
Total cost per ton	12.79	2.35	19.11	10.77
Number of trucks on overtime	9.00			

Each run of Models 1 and 2 produced six tables similar to the above. Each of the tables gave results for 30 trucks operating at the same haul distance, 1, 4, 8, 12, 18, or 24 miles. A lead statement before the tables gave other run conditions of neighborhood type, season, collection frequency, etc.

CHAPTER 4: RESULTS FROM MODELS 1 AND 2

A. Number of housing units serviced by a truck per day

Model 1 was programmed to simulate individual trucks working a full eight hour day yet hopefully not on overtime. As in actual operations, some trucks in the model found traffic slow, dumping time long, and themselves on overtime. Runs of Model 1 combined semiweekly and triweekly collection frequencies with the four neighborhood types for two sizes of collection trucks. The term "run" is used here for the simulation of the activity of six groups, each of thirty trucks, all collecting solid waste under the same variable values of days since last collection, neighborhood type, season, collection frequency, and size of truck. However each group of thirty trucks has a different haul distance from its collection neighborhood to the disposal site.

Tables 4-1 and 4-2 show the average number of households served and the average gross acreage from which collection was made by the larger trucks. Figure 4-1 may be used for preliminary planning as it gives the average number of households which may be serviced as a function of the variables which most strongly affect the result. In general, the smaller trucks served from 85% to 95% of the number of units shown for the larger

RUN NO.	NETYP	HAUL DISTANCES IN MILES 1	4	8	12	18	24
5	1	1150	988	836	812	738	624
6	2	1425	1087	984	975	771	662
7	3	1268	1020	890	885	713	658
8	4	1115	953	827	756	705	615

SEMIWEEKLY COLLECTION FREQUENCY

RUN NO.	NETYP	HAUL DISTANCES IN MILES 1	4	8	12	18	24
13	1	1200	1062	987	896	781	755
14	2	1904	14/2	1294	1224	1069	886
15	3	1683	1397	1208	1149	948	887
16	4	1554	1250	1086	1026	902	807

TRIWEEKLY COLLECTION FREQUENCY

TABLE 4-1
AVERAGE NUMBER OF HOUSING UNITS
SERVED PER DAY PER TRUCK

RUN NO.	NETYP	HAUL DISTANCE IN MILES 1	4	8	12	18	24
5	1	252	223	178	190	183	137
6	2	139	108	96	97	72	64
7	3	77	61	53	53	42	40
8	4	42	37	31	29	26	23

SEMIWEEKLY COLLECTION FREQUENCY

RUN NO.	NETYP	HAUL DISTANCE IN MILES 1	4	8	12	18	24
13	1	274	236	219	230	217	175
14	2	147	179	118	125	102	82
15	3	83	100	67	73	56	52
16	4	46	46	37	41	34	30

TRIWEEKLY COLLECTION FREQUENCY

TABLE 4-2
NUMBER OF GROSS ACRES SERVED
PER DAY PER TRUCK

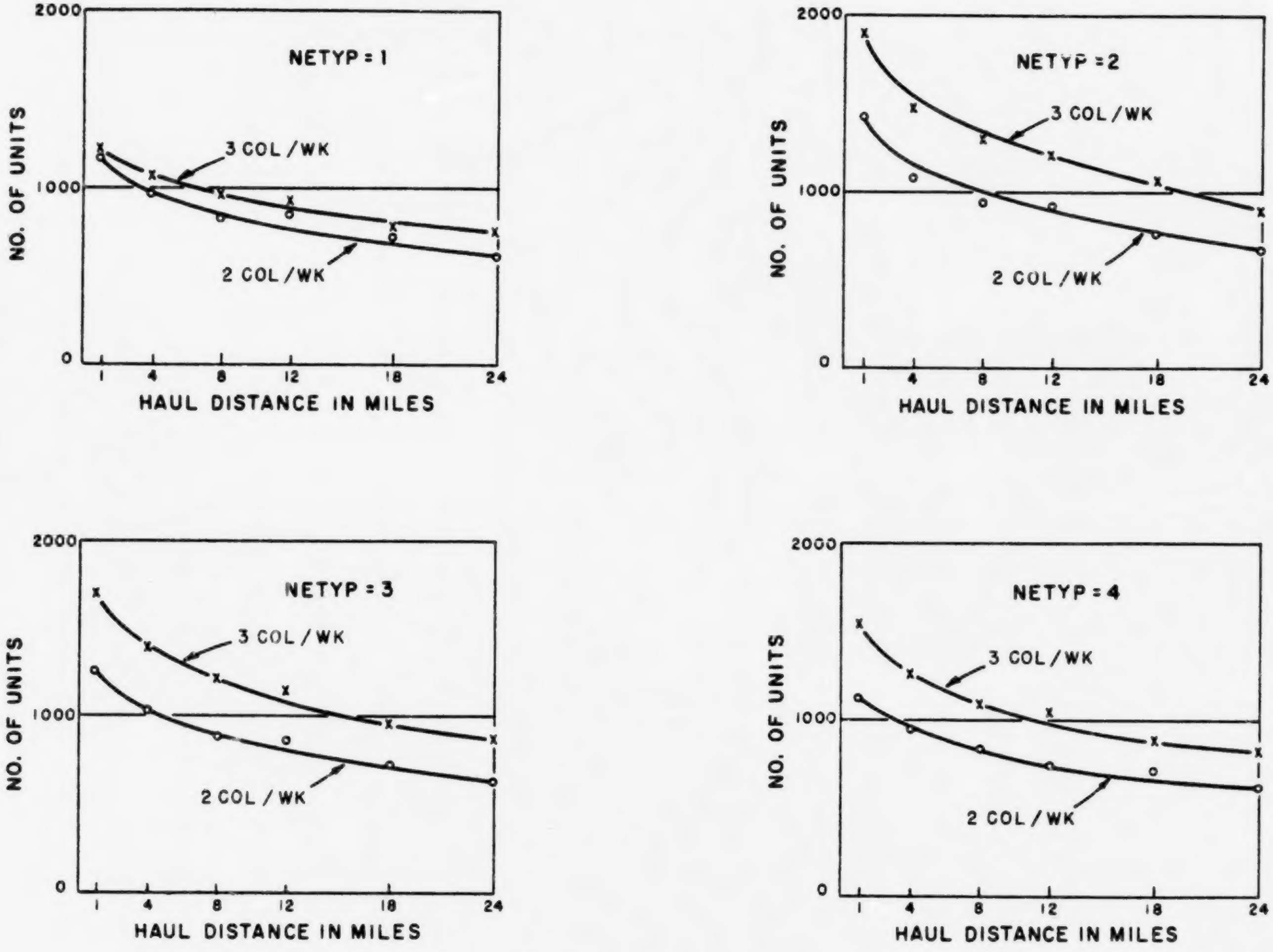


FIGURE 4 - 1

Average Number of Households Served Daily, Models 1 and 2 trucks for the same run conditions. Figure 4-2 is of less general application, as the results in it are completely dependent on the ratio of gross acres to net acres in the city of Baltimore.

B. Sensitivity of responses to different random number sequences

Twenty-four values of results from each of three successive runs are shown in Table 4-3. All affecting variables were held constant, but the stochastic events were generated by different random number sequences. Figure 4-3 shows graphically some of the same values.

C. Sensitivity of response to season

Model 1 gave the average number of units which could be serviced by a single truck under controlled conditions of haul distance to incinerator, neighborhood type in which collection was being done, type of truck, etc. Model 1 also gave the average unit cost of the entire day's operation for the thirty trucks involved in dollars per ton. The data showed no statistically significant difference in the collection rates between summer and winter, but did indicate significant difference in the pounds per person of solid waste generated. Table 4-4 shows results from six runs of these models made for the purpose of observing season effect on unit costs and on the average number of units which an individual truck could service in a day. Figure 4-4 shows the same information graphically.

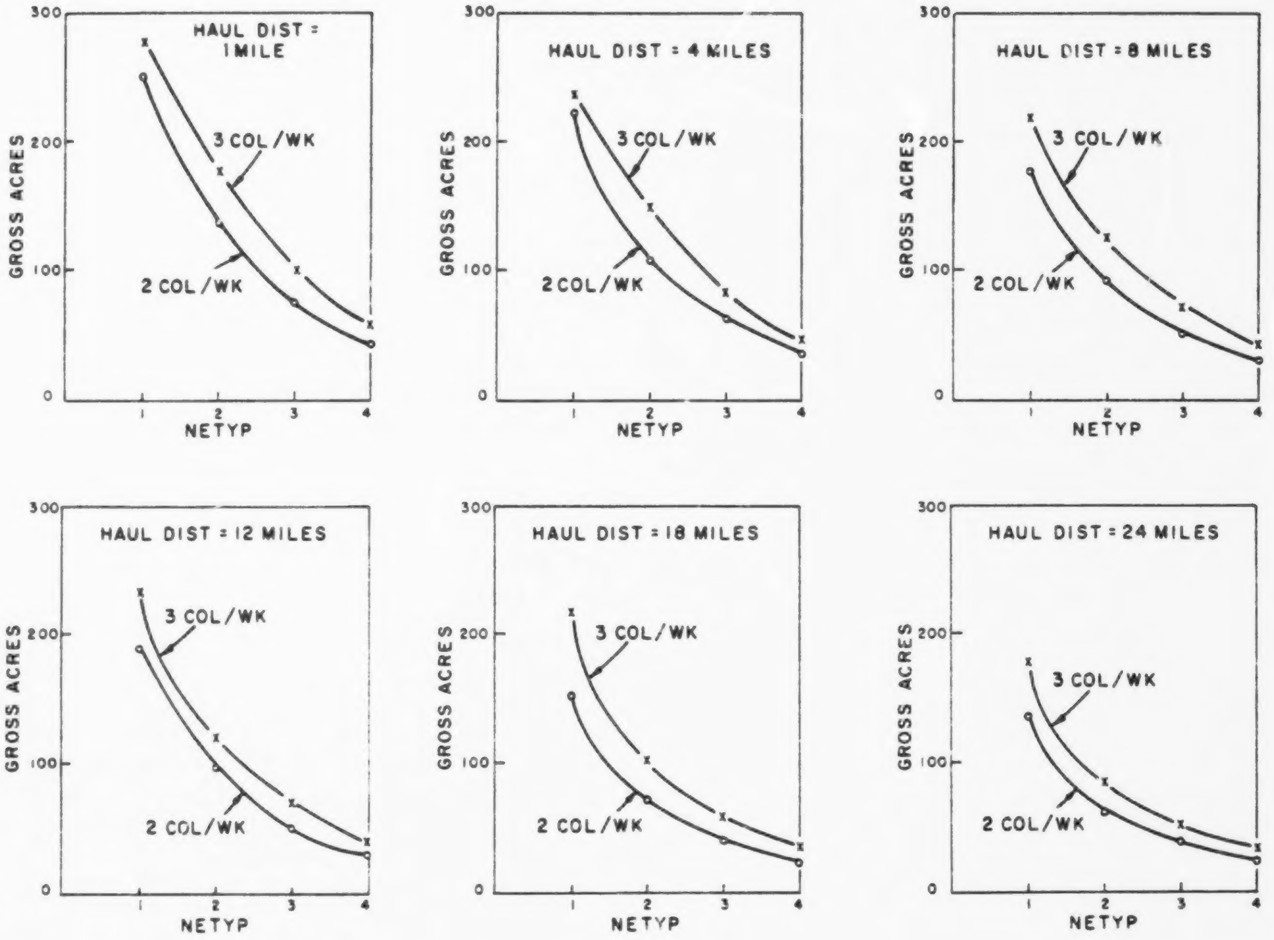


FIGURE 4 - 2

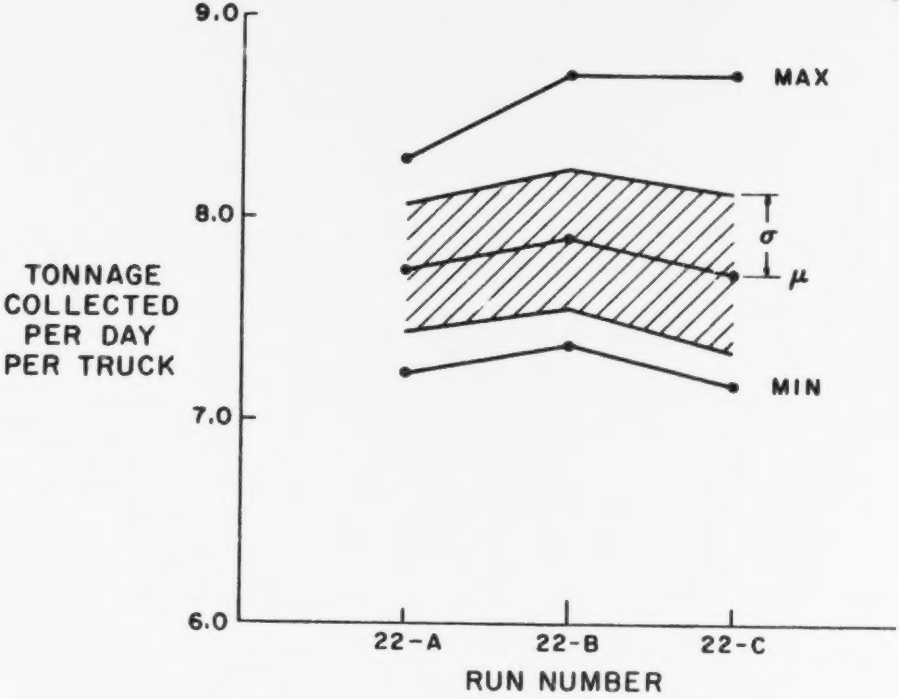
Average Gross Acres Served Daily, Model 1

	Run 22-A				Run 22-B				Run 22-C			
	Mean	Stnd Dev	Max	Min	Mean	Stnd Dev	Max	Min	Mean	Stnd Dev	Max	Min
Tonnage Collected	7.75	0.32	8.28	7.25	7.90	0.36	8.70	7.37	7.73	0.40	8.72	7.18
Hours of Work	7.12	0.42	8.37	6.62	7.24	0.59	9.02	6.22	7.14	0.57	9.37	6.07
Per Cent Time Collecting	47.0	7.3	66.3	34.2	49.5	8.1	71.6	33.7	46.5	8.0	67.9	30.2
Per Cent Time in Traffic	23.1	3.6	31.3	16.8	21.9	3.4	30.2	15.1	22.7	3.6	30.5	16.8
Cost ($) per Ton	11.35	0.78	14.05	10.52	11.29	1.02	14.70	10.20	11.39	0.73	13.90	10.16
No. of Overtime Trucks	2	-	-	-	2	-	-	-	1	-	-	-

TABLE 4-3

RESULTS FROM 3 INDEPENDENT RUNS FOR MODEL 1

Summer
Two days since last collection
Collection frequency of 3/week
Truck size of 20 cubic yards
Haul of eight miles
Neighborhood type is 2
Crew size is driver and 2 laborers



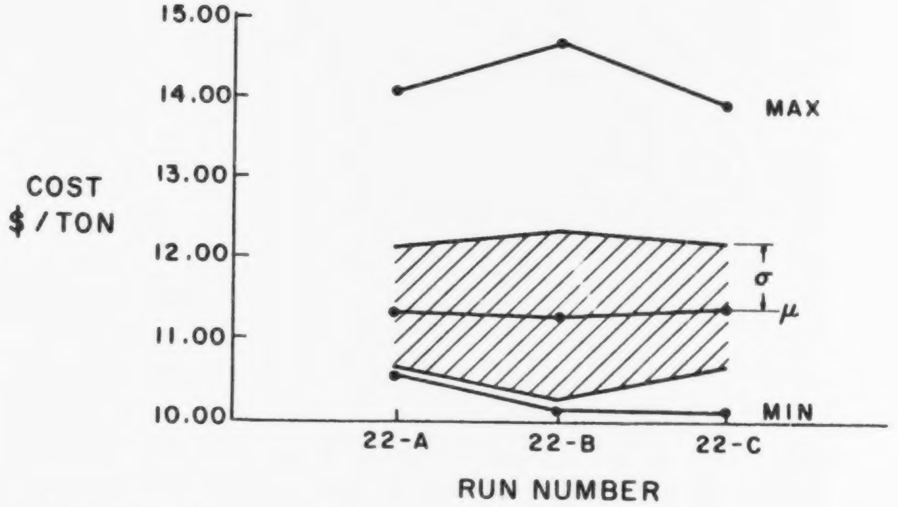


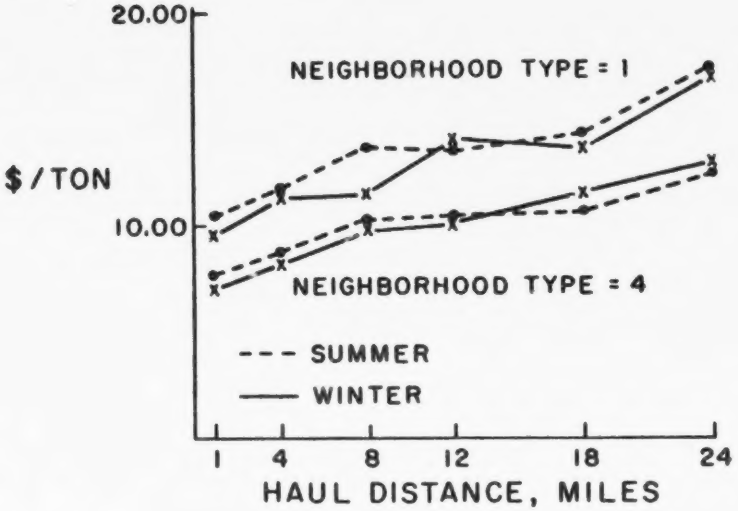
FIGURE 4 - 3

Sensitivity of Results to Different Random Number Sequences

Season	Run No.	Neighborhood Type	Haul Distance 1	4	8	12	18	24
					($ per ton cost)			
Summer	5	1	10.38	11.96	13.96	13.43	14.11	17.38
Winter	30	1	9.71	11.70	13.71	13.71	13.41	17.16
Summer	8	4	7.71	8.90	10.54	10.54	10.72	12.35
Winter	32	4	7.04	8.85	10.33	10.33	11.52	12.76
					(No. units serviced)			
Summer	8	4	1115	953	827	756	705	615
Winter	32	4	1393	1114	966	896	764	695

TABLE 4-4

SENSITIVITY OF SEASON ON UNIT COSTS AND ON NUMBER OF HOUSEHOLDS SERVICED



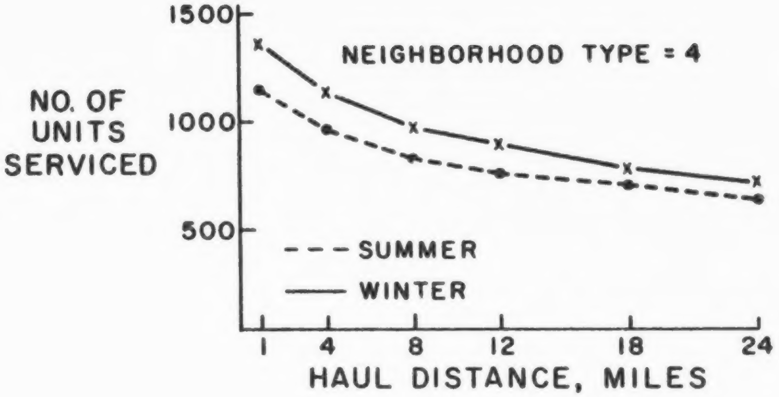


FIGURE 4 - 4

Sensitivity of Results to Seasonal Effects

D. Cost comparison of semiweekly and triweekly collection frequencies

Model 2 gave average unit cost in dollars per ton for thirty trucks operating a full day under task assignment of μ households per truck. The μ assigned was that which Model 1 had produced under its similar program, which had a workday closely averaging eight hours.

For semiweekly collection frequency, the trucks in Model 2 were assigned the μ obtained from Model 1's run with the same variable values of neighborhood type, haul distance, truck type, etc., and with four days having passed since last collection. This number of households continued to be the assignment for the trucks' second passage over the route during the last half of the week. Three days since last collection is programmed for this latter collection of the week. This arrangement results in a longer average workday and a greater average tonnage for the first trip of the week than for the last. For this hypothetical route, the tonnage collected for the week is the sum of the tonnages for the two days; the total cost of the week is the sum of total costs of the two days; and the unit cost is this total cost divided by total tonnage.

For a triweekly collection frequency, the tonnages collected from three days' activities were summed; the total costs of three days' activities were summed; and a quotient of dollars per ton was found. The first of the three days' activities was programmed in Model 2 with a μ assignment of households equal to that average given by Model 1 under the given conditions with three days having passed since last collection. This μ number of households was also the assignment for each truck both for the second and third collections of the week. Two days since last collection are programmed for these last two collections of the week. This arrangement again resulted in a longer average workday and a greater average tonnage for Monday and Tuesday than for the remaining four workdays of the week.

To illustrate:

TRIWKCOS = cost in dollars per ton of triweekly collection from a neighborhood type 1 with a haul distance of 8 miles

DOLCOS17 = average day's cost for a truck with haul distance of 8 miles, from Run 17

TOTTON17 = average total tonnage collected by a truck with haul distance of 8 miles, from Run 17

DOLCOS21 = average day's cost for a truck with haul distance of 8 miles, from Run 21

TOTTON21 = average total tonnage collected by a truck with haul distance of 8 miles, from Run 21

$$\text{TRIWKCOS} = \frac{\text{DOLCOS 17} + 2\,(\text{DOLCOS 21})}{\text{TOTTON 17} + 2\,(\text{TOTTON 21})}$$

Tables D-1 through D-6 in Appendix D show data from runs and tabulation of calculations.

Figure 4-5, 4-6, and 4-7 show unit costs of semiweekly and triweekly collections by neighborhood types. These plotting arrangements allow comparison of costs either with neighborhood types as the primary variable being compared or with the collection frequency as the variable of primary interest.

Most urban collection systems in the United States are of semiweekly frequency. An attempt has been made to approximate the cost increase if triweekly collection became common. Figure 4-8 summarizes the answers which Model 2 gave to this question. Two envelopes are drawn; one for the least densely populated neighborhood type 1 and the other encompassing the complex of points from the three denser neighborhood types.

E. The relative effects of variables on unit costs

A five way analysis of variance study was made to determine the significance of different variables on the cost in dollars per ton of the entire collection operation. The variables studied were:

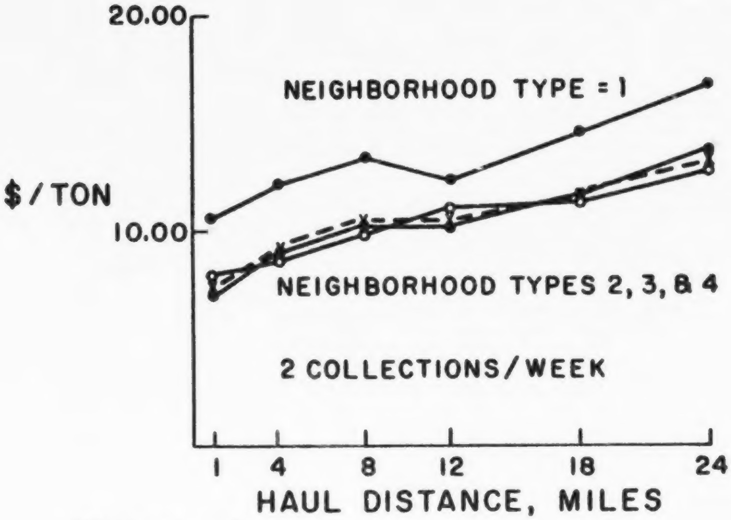


FIGURE 4 - 5

Collection Costs

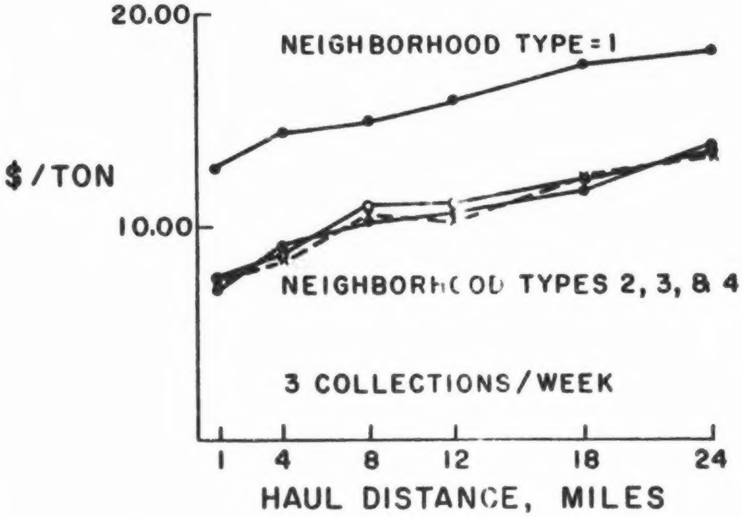


FIGURE 4 - 6

Collection Costs

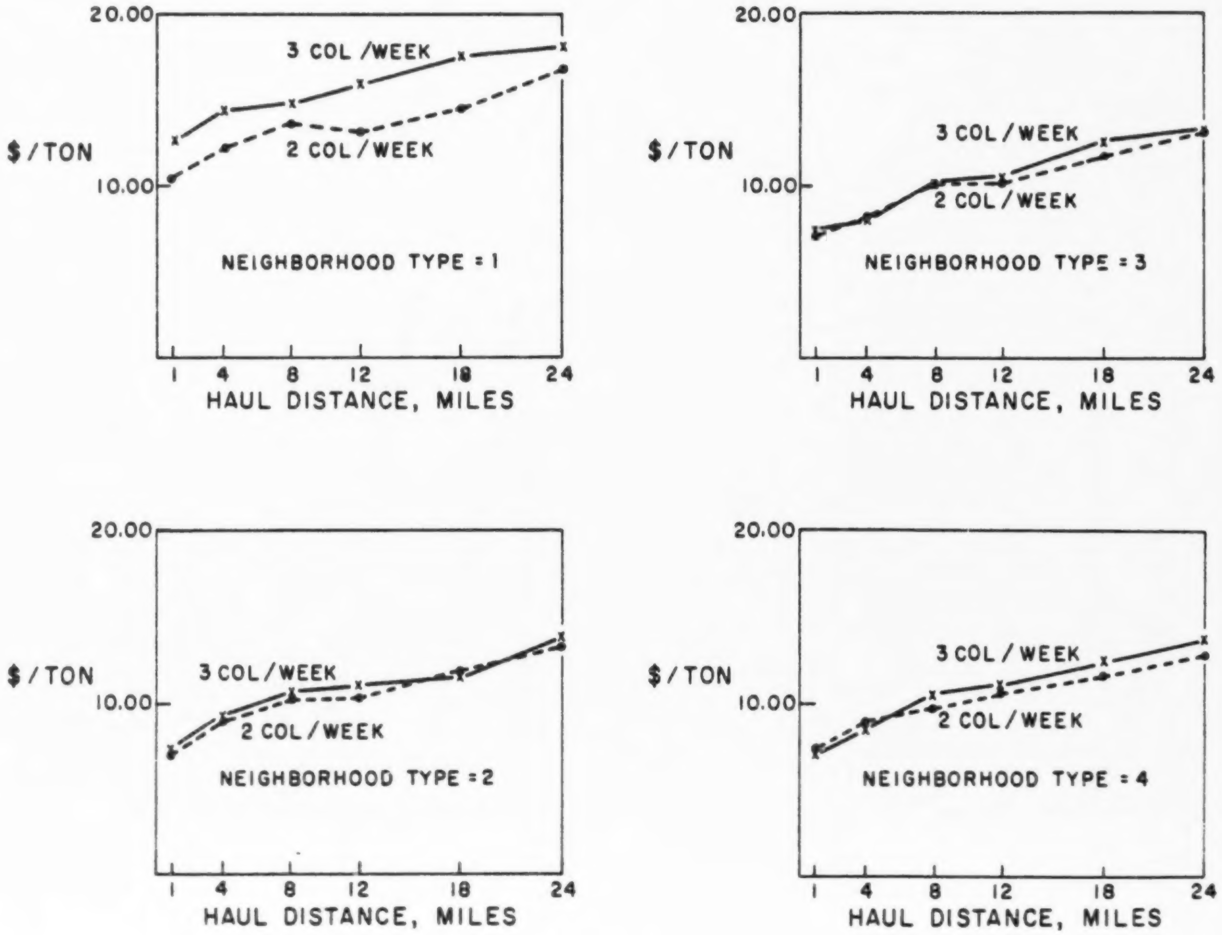


FIGURE 4 - 7

Collection Costs

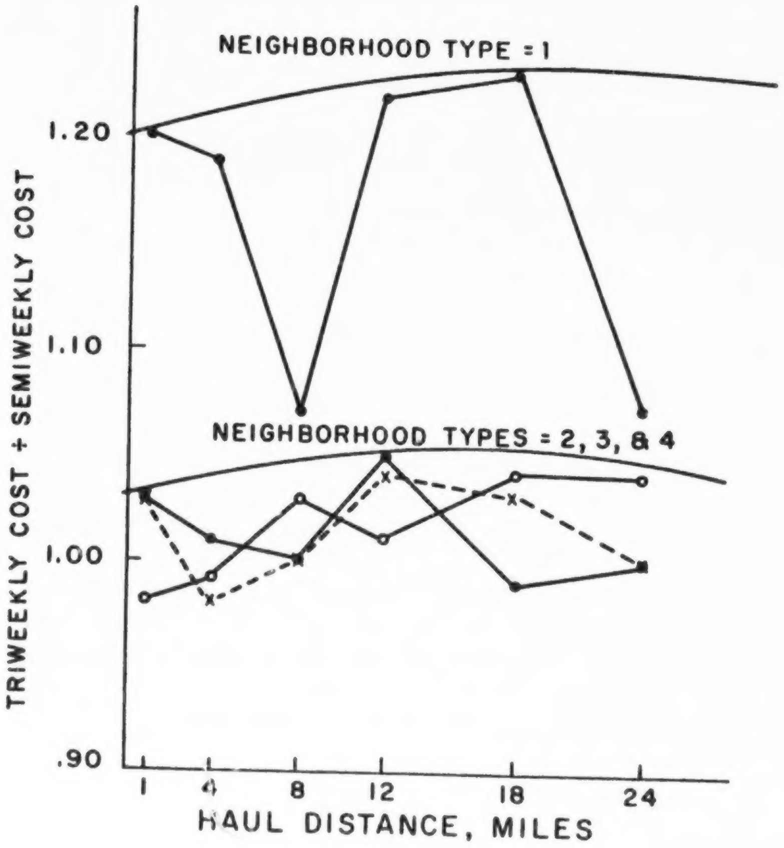


FIGURE 4 - 8

Summary of Cost Comparision of Semiweekly and Triweekly Collection

1) Capacity of trucks, three tons and five tons
2) Density per acre of housing units, less than ten units and more than forty units
3) Seasonal conditions, summer and winter
4) Days since last collection, three and four
5) Haul distance, four miles and eight miles

Table 4-5 is the matrix for this study. The relative significance of the variables on the cost is indicated in Table 4-6.

This shows significance is indicated at the 0.001 level for Housing Density. Significance is indicated at the 0.05 level for the effect of the number of Days Since Last Collection, the effect of Haul Distance, and the two-way interaction of Housing Density and Days Since Last Collection.

F. Percentage of worktime in different activities

The Models gave averages of times spent by trucks in different activities during the day. Table 4-7 gives average values for two runs showing time divisions for the different combinations of two neighborhood types and six haul distances. Figure 4-9 shows the same information graphically.

	SMALL TRUCK																LARGE TRUCK															
	NETYP=1								NETYP=4								NETYP=1								NETYP=4							
	Summer				Winter				Summer				Winter				Summer				Winter				Summer				Winter			
DSLC	3		4		3		4		3		4		3		4		3		4		3		4		3		4		3		4	
HAUL DIST	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8
A	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	x	x	x	x	x	x	x	x	-	-	-	-	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-	-	-	-	-	-
C	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-
D	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-
E	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-
AB	x	x	x	x	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x	x	x	x	x	x
AC	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-
AD	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-
AE	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-	x	-
BC	x	x	x	x	-	-	-	-	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-	-	-	-	-	-	x	x	x	x
BD	x	x	-	-	x	x	-	-	-	-	x	x	-	-	x	x	x	x	-	-	x	x	-	-	-	-	x	x	-	-	x	x
BE	x	-	x	-	x	-	x	-	-	x	-	x	-	x	-	x	x	-	x	-	x	-	x	-	-	x	-	x	-	x	-	x
CD	x	x	-	-	-	-	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-	x	x	x	x	-	-	-	-	x	x
CE	x	-	x	-	-	x	-	x	x	-	x	-	-	x	-	x	x	-	x	-	-	x	-	x	x	-	x	-	-	x	-	x
DE	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x	x	-	-	x
VALUES S/ton	13.07	12.71	12.74	13.59	12.65	13.32	11.41	13.41	7.75	8.40	9.18	10.21	7.77	8.57	9.66	11.02	11.67	11.93	11.96	13.96	10.80	12.96	11.70	11.34	7.38	8.39	8.90	10.10	7.32	8.18	8.85	10.06

TABLE 4-5
Analysis of Variance Matrix

	Source of Deviation	Sum of Squares	Degrees of Freedom	Mean Squares	Fraction
A	Capacity of Trucks	3.10	1	3.10	3.22
B	Housing Density	103.25	1	103.25	108.66**
C	Seasons	0.26	1	0.26	0.28
D	Days since last Collection	7.24	1	7.24	7.51*
E	Haul distance	7.35	1	7.35	7.73*
	Two way interactions of				
AB	Trucks and Housing Density	0.32	1	0.32	0.34
AC	Trucks and Season	0.33	1	0.33	0.35
AD	Trucks and Days	0.05	1	0.05	0.05
AE	Trucks and Haul Distance	0.06	1	0.06	0.06
BC	Housing Density and Season	0.83	1	0.83	0.87
BD	Housing Density and Days	5.46	1	5.46	5.74*
BE	Housing Density and Haul Dist.	0.03	1	0.03	0.03
CD	Seasons and Days	0.37	1	0.37	0.39
CE	Seasons and Haul Distance	0.13	1	0.13	0.14
DE	Days and Haul Distance	0.33	1	0.33	0.35
	Error	15.12	16	0.951	--

* F(1,16)0.05 = 4.54

** F(1,16)0.001 16.6

TABLE 4-6

Relative Significance of Variables on Costs

			Per Cent of Time Spent				
Run	NETYP	Haul Dist	Collecting	Traffic	Incinerator	Off-Route	
33	1	1	74	6	4	16	100
		4	57	22	3	18	100
		8	53	23	3	21	100
		12	55	21	3	21	100
		18	44	27	2	27	100
		24	40	34	3	23	100
35	3	1	71	9	5	15	100
		4	60	22	4	14	100
		8	49	30	4	17	100
		12	48	32	3	16	100
		18	46	27	3	24	100
		24	39	35	3	23	100

TABLE 4-7
PERCENTAGE DIVISION OF WORKING DAY

Note: Collection frequency is semiweekly and four days since last collection.

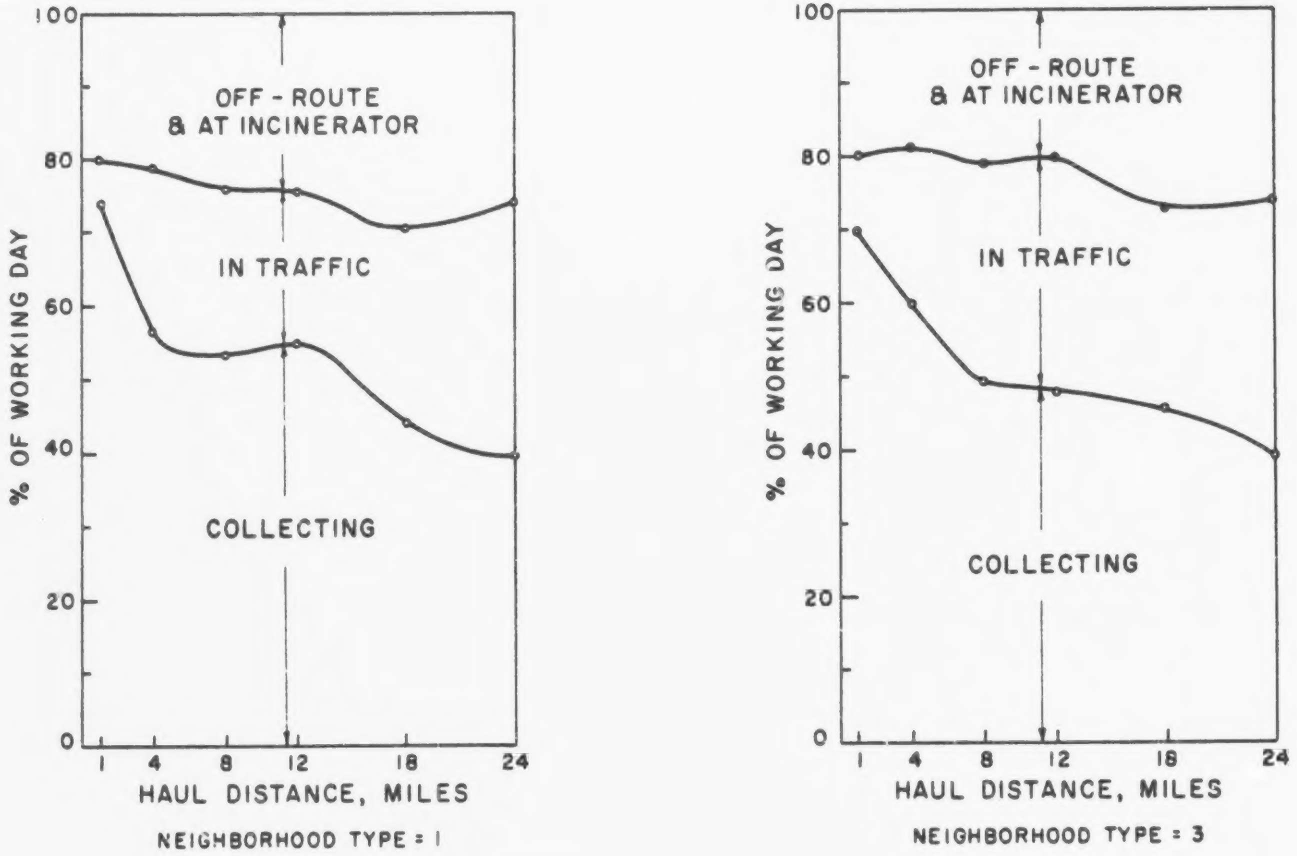


FIGURE 4 - 9

Percentage of Time Spent by Crews in Different Activities

G. Effect of varying the number of assigned units

Model 2 was programmed so that each group of trucks, thirty in number, was assigned a definite number of household units per truck per day. This number was the mean of the number of households serviced in Model 1 under similar conditions of the affecting variables, collection frequency, neighborhood type, etc. It seemed possible that this mean might not be the optimal number for assignment. Perhaps a smaller assignment might remove all trucks from overtime and so lower the cost per ton; or perhaps a larger assignment would cause all crews to work at least the full eight-hour day for which they received pay and so lower the cost per ton.

The following runs were made to secure results for comparison of dollars per ton costs of semiweekly collection under the conditions shown:

Run Number	Assigned Task	Days since last Collection	Neighborhood Type
34	μ	4	2
51	$\mu - \sigma$	4	2
52	$\mu + \sigma$	4	2
38	μ	3	2
71	$\mu - \sigma$	3	2
72	$\mu + \sigma$	3	2
35	μ	4	3
55	$\mu - \sigma$	4	3
56	$\mu + \sigma$	4	3
39	μ	3	3
75	$\mu - \sigma$	3	3
76	$\mu + \sigma$	3	3
33	μ	4	1
81	$\mu - \sigma$	4	1
83	$\mu + \sigma$	4	1
37	μ	3	1
82	$\mu - \sigma$	3	1
84	$\mu + \sigma$	3	1

Tables D-7 to D-12 in Appendix D give the results from the above and calculation tabulations.

After making these runs, no inflection points were within the range investigated; therefore four more runs were made for the purpose of extending the curves in the direction of decreasing cost values.

Run Number	Assigned Task	Days since last Collection	Neighborhood Type
53	$\mu + 3\sigma$	4	2
73	$\mu + 3\sigma$	3	2
57	$\mu + 3\sigma$	4	3
77	$\mu + 3\sigma$	3	3

The results from the above and calculation tabulations are also in Tables D-7 to D-12 in Appendix D.

Figure 4-10 shows cost results graphically. The curves decrease asymptotically in the direction of increasing task assignments. Figure 4-11 shows the number of trucks out of each set of thirty which went on overtime for the indicated conditions.

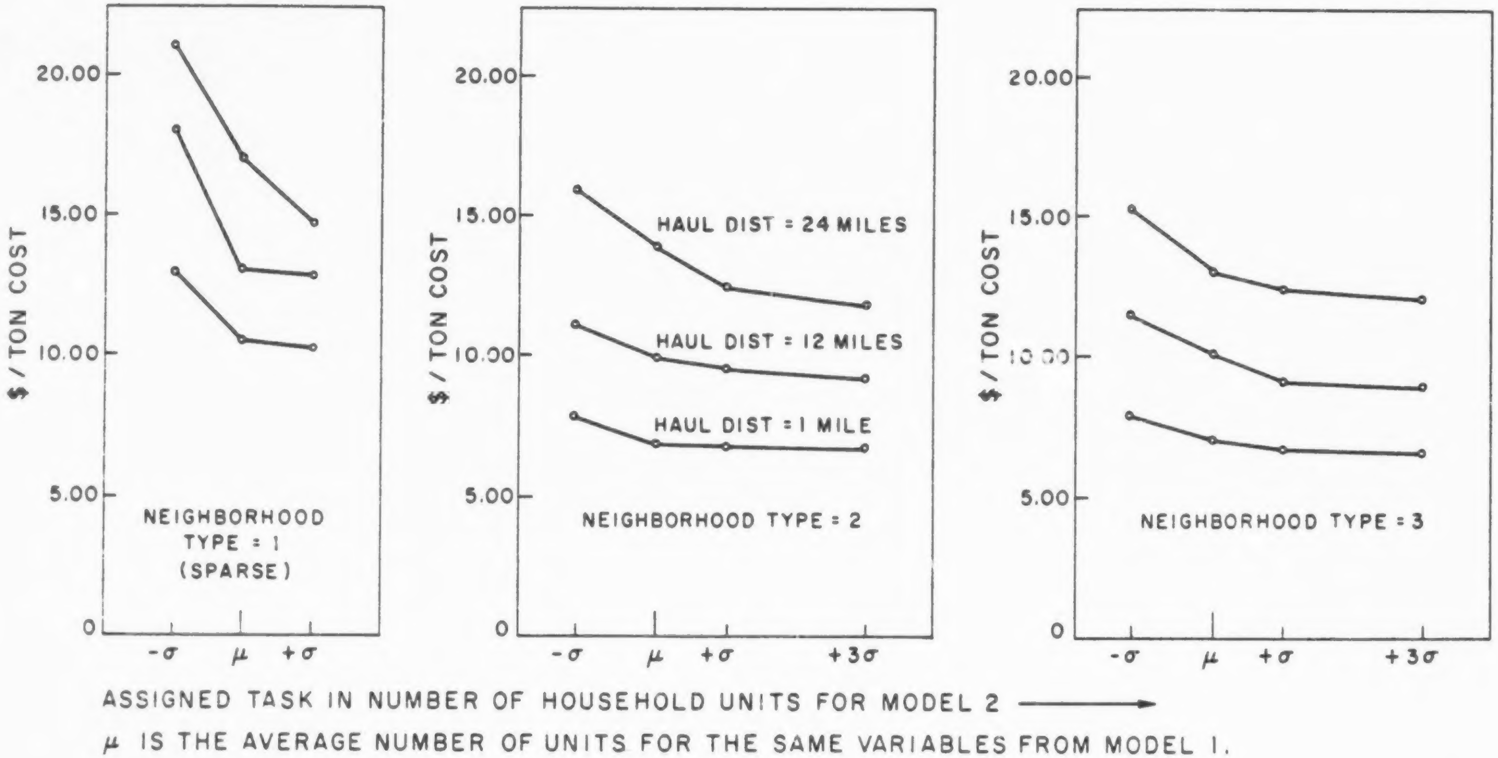
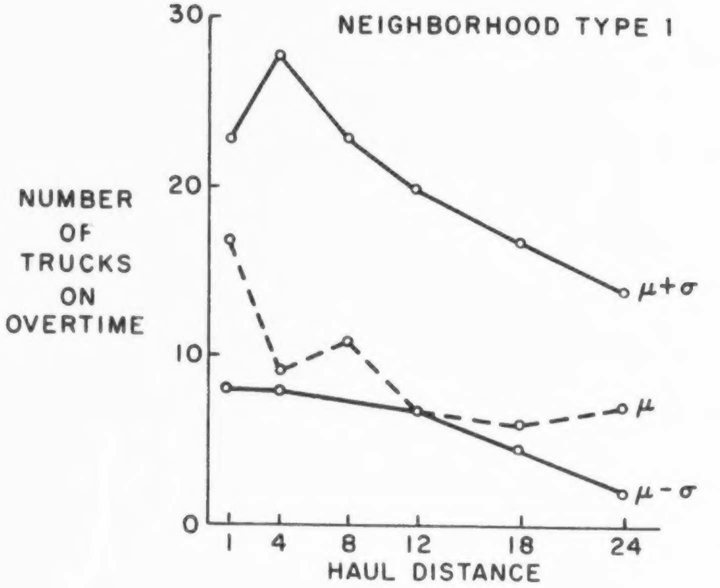


FIGURE 4 - 10

Variation in Unit Costs with Size of Daily Task Assignments



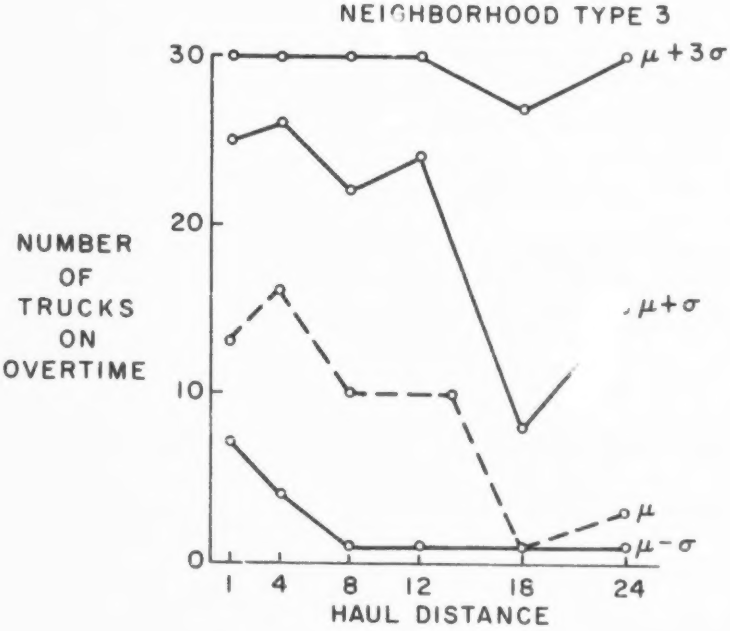


FIGURE 4 - 11

Number of Trucks on Overtime with Different Daily Tasks

CHAPTER 5: THE POLICIES AND STRUCTURE OF MODEL 3

Model 3 has been described briefly in Chapter I. A more detailed discussion follows, giving the nature of the model, the controllable variables, the range of values which may be given them, and the mechanics of usage.

Frequent reference will be made in this chapter to a "run" of Model 3. A run simulates collection activity by 20 cubic yard collection trucks in a particular urban area for one week, Monday through Saturday. The area may be composed of many subareas of different population densities, all having solid waste collection being made by one agency under a set of policies which remain constant for the entire week. A transfer station may or may not be present in the model. Model responses include the week's costs in dollars per ton of the collection trucks operation, of the transfer station operation, and of their sum. Mileage figures, distribution of overtimes, summation of trips made, tonnage by days, costs by days, average length of working days, etc., are also presented. Table 5-1 is a sample of Model 3 results.

SOLID WASTE COLLECTION SIMULATION RUN NUMBER 23

MODEL THREE

THIS IS A SIMULATION RUN ON A PORTION OF THE CITY OF BALTIMORE, APPROXIMATELY DESCRIBED AS 'THAT TRACT BOUNDED ON THE NORTH BY THE CITY LIMITS, ON THE EAST BY YORK AVENUE, ON THE SOUTH BY NORTH AVENUE, AND ON THE WEST BY THE CITY LIMITS.'

WITHIN THIS TRACT, 13 RESIDENTIAL AREAS, EACH OF PARTICULAR HOUSING DENSITY, HAVE BEEN GIVEN NUMBER DESIGNATIONS FROM 1 TO 13. TABLE ONE BELOW LISTS THESE AREAS AND DATA PERTINENT TO EACH. 24 COLLECTION TRUCKS, ALL COMPACTER TYPE ARE OF 20 CUBIC YARD CAPACITY, HAVE BEEN ASSIGNED TO THESE 13 AREAS TO MAKE COLLECTION 2 TIMES PER WEEK.

THE CREWS ASSIGNED TO THE TRUCKS ARE A DRIVER AND THREE LABORERS ON MONDAYS, TUESDAYS AND WEDNESDAYS, AND A DRIVER AND TWO LABORERS ON THE REMAINING DAYS.

TABLE TWO LISTS THE ASSIGNED COLLECTION TRUCKS BY NUMBER AND LISTS DATA PERTINENT FOR EACH.

TABLE 5-1A

*** TABLE ONE ***

AREA NUMBER	NEIGHBOR-HOOD TYPE	HOUSING UNITS TOTAL	TRUCKS HAUL MILES	ASSIGNED UNITS PER TRUCK	NUMBER OF ROUTES
1	1	5711	3.28	951	6
2	2	1099	2.25	1099	1
3	1	6124	2.35	1020	6
4	2	2079	1.31	1039	2
5	3	11186	0.49	1118	10
6	2	9659	2.39	1207	8
7	1	7299	1.57	1042	7
8	2	1887	2.37	943	2
9	3	5906	1.69	1181	5
10	4	10519	3.05	956	11
11	4	6731	3.30	961	7
12	3	2317	2.59	1158	2
13	3	3937	3.24	984	4

TABLE 5-1B

```
                        *** TABLE  TWO ***

TRUCK    ASSIGNED    UNITS TO    HAUL       NEIGHBOR-    DAYS TO
NUMBER   TO AREA     COLLECT   DISTANCE     HOOD TYPE    COLLECT
    1        1         951       3.28           1         MONTHU
    1        1         951       3.28           1         TUEFRI
    1        1         951       3.28           1         WEDSAT
    2        1         951       3.28           1         MONTHU
    2        1         951       3.28           1         TUEFRI
    2        1         951       3.28           1         WEDSAT
    3        2        1099       2.25           2         MONTHU
    3        3        1020       2.35           1         TUEFRI
    3        3        1020       2.35           1         WEDSAT
    4        3        1020       2.35           1         MONTHU
    4        3        1020       2.35           1         TUEFRI
    4        3        1020       2.35           1         WEDSAT
    5        3        1020       2.35           1         MONTHU
    5        4        1039       1.31           2         TUEFRI
    5        4        1039       1.31           2         WEDSAT
    6        5        1118       0.49           3         MONTHU
    6        5        1118       0.49           3         TUEFRI
    6        5        1118       0.49           3         WEDSAT
    7        5        1118       0.49           3         MONTHU
    7        5        1118       0.49           3         TUEFRI
    7        5        1118       0.49           3         WEDSAT
    8        5        1118       0.49           3         MONTHU
    8        5        1118       0.49           3         TUEFRI
    8        5        1118       0.49           3         WEDSAT
    9        5        1118       0.49           3         MONTHU
    9        6        1207       2.39           2         TUEFRI
    9        6        1207       2.39           2         WEDSAT
   10        6        1207       2.39           2         MONTHU
   10        6        1207       2.39           2         TUEFRI
   10        6        1207       2.39           2         WEDSAT
   11        6        1207       2.39           2         MONTHU
   11        6        1207       2.39           2         TUEFRI
   11        6        1207       2.39           2         WEDSAT
   12        7        1042       1.57           1         MONTHU
   12        7        1042       1.57           1         TUEFRI
   12        7        1042       1.57           1         WEDSAT
   13        7        1042       1.57           1         MONTHU
   13        7        1042       1.57           1         TUEFRI
   13        7        1042       1.57           1         WEDSAT
   14        7        1042       1.57           1         MONTHU
```

TABLE 5-1C

*** TABLE TWO ***
(CONTINUED)

TRUCK NUMBER	ASSIGNED TO AREA	UNITS TO COLLECT	HAUL DISTANCE	NEIGHBOR-HOOD TYPE	DAYS TO COLLECT
14	8	943	2.37	2	TUEFRI
14	8	943	2.37	2	WEDSAT
15	9	1181	1.69	3	MONTHU
15	9	1181	1.69	3	TUEFRI
15	9	1181	1.69	3	WEDSAT
16	9	1181	1.69	3	MONTHU
16	9	1181	1.69	3	TUEFRI
16	10	956	3.05	4	WEDSAT
17	10	956	3.05	4	MONTHU
17	10	956	3.05	4	TUEFRI
17	10	956	3.05	4	WEDSAT
18	10	956	3.05	4	MONTHU
18	10	956	3.05	4	TUEFRI
18	10	956	3.05	4	WEDSAT
19	10	956	3.05	4	MONTHU
19	10	956	3.05	4	TUEFRI
19	10	956	3.05	4	WEDSAT
20	10	956	3.05	4	MONTHU
20	11	961	3.30	4	TUEFRI
20	11	961	3.30	4	WEDSAT
21	11	961	3.30	4	MONTHU
21	11	961	3.30	4	TUEFRI
21	11	961	3.30	4	WEDSAT
22	11	961	3.30	4	MONTHU
22	11	961	3.30	4	TUEFRI
22	12	1158	2.59	3	WEDSAT
23	12	1158	2.59	3	MONTHU
23	13	984	3.24	3	TUEFRI
23	13	984	3.24	3	WEDSAT
24	13	984	3.24	3	MONTHU
24	13	984	3.24	3	TUEFRI
24	0	0	0.00	0	WEDSAT

TABLE 5-1D

IN THIS RUN THERE IS A TRANSFER STATION WHERE THE COLLECTION TRUCKS BRING THEIR LOADS, THE SOLID WASTE IS TRANSFERRED TO 75 CUBIC YARD TRAILERS AND CARRIED IN THESE TRAILERS PULLED BY TRACTORS TO THE FINAL DISPOSAL SITE. THE TRANSFER STATION IN THIS RUN HAS A CAPACITY OF 290 TONS PER DAY AND REQUIRES AN INITIAL INVESTMENT OF $428000.00,THE FINAL DISPOSAL SITE IS AT COORDINATES FX =-39600., FY = 39000. THE TRANSFER STATION IS AT CO-ORDINATES, TX = 66000., TY = 39000. THE DISTANCE FROM THE TRANSFER STATION TO THE FINAL DISPOSAL SITE IS 20.0 MILES. 5 TRAILERS AND 2 TRACTORS WORK OUT OF THE TRANSFER STATION.

THE MAP TITLED 'MAP FOR SIMULATION RUN 23 SHOWS THE RESIDENTIAL AREA DIVISIONS AND THE LOCATIONS OF THE TRANSFER STATION AND THE FINAL DISPOSAL SITE. THE RUN HAS SIMULATED ONE WEEKS OPERATION, AND THE RESULTS ARE SHOWN BELOW.

1. COST OF COLLECTION TRUCKS OPERATION ...	13663.19
2. COST OF TRANSFER STATION AND TRAILER TRACTOR OPERATION ...	2371.00
3. TOTAL COST OF WEEKS ACTIVITY	16034.19
4. TONNAGE COLLECTED IN WEEK	1535.48
5. DOLLARS PER TON COST FOR COLLECTION TRUCKS OPERATION ...	8.90
6. DOLLARS PER TON COST FOR TRANSFER STATION AND TRACTOR OPERATION ...	1.54
7. DOLLARS PER TON FOR ENTIRE WEEKS WORK ...	10.44
8. COLLECTION TRUCK TRAFFIC MILEAGE	1826.9
9. COLLECTION TRUCK NEIGHBORHOOD MILEAGE ...	2024.7
10. TRAILER TRACTOR TRAFFIC MILEAGE	1920.0

TABLE 5-1E

```
11. NUMBER OF COLLECTION TRUCKS GETTING
    ONE HOUR OF OVERTIME DURING WEEK  .......      9

12. NUMBER OF COLLECTION TRUCKS GETTING
    TWO HOURS OF OVERTIME DURING WEEK  ......      6

13. NUMBER OF TRUCKS GETTING MORE THAN
    TWO HOURS OF OVERTIME DURING WEEK  ......      2

14. THERE WERE   1  BREAKDOWNS OR FLAT TIRES ON
    COLLECTION TRUCKS DURING THE WEEK.

15. THE COLLECTION TRUCKS MADE   412 TRIPS DURING
    THE WEEK.

16. THE TRAILER TRACTOR RIGS MADE    48 TRIPS
    DURING THE WEEK.

                           AVE   SIG   MAX   MIN
17. TIME IN MINUTES
    IN DISPOSAL .....  7.74  3.85 25.00  2.00

18. PERCENT TIME SPENT BY COLLECTION TRUCKS
              IN COLLECTING...      57.9
              IN TRAFFIC .....      14.2
              IN DISPOSAL ....       5.1
              OFF ROUTE ......      22.8

                           AVE   SIG   MAX   MIN
19. HOURS IN WORKDAY     6.5   1.3  12.8   4.1
```

TABLE 5-1F

```
20. PERCENT OF TIME THAT TRANSFER
    STATION QUEUES WERE
                                QUEUE 1    QUEUE 2
                 NO TRUCKS       57.27      64.57
                ONE TRUCK        29.95      27.92
                TWO TRUCKS       10.58       7.05
              THREE TRUCKS        2.16       0.44
               FOUR TRUCKS        0.03       0.00
               FIVE TRUCKS        0.00       0.00
                SIX TRUCKS        0.00       0.00
              SEVEN TRUCKS        0.00       0.00
              EIGHT TRUCKS        0.00       0.00
               NINE TRUCKS        0.00       0.00
                TEN TRUCKS        0.00       0.00
                      MORE        0.00       0.00

21. MAXIMUM LENGTH OF QUEUE IS      4

22. RESUME OF WEEK
       DAY    WEIGHT COLLECTED    COST OF DAY
                  IN TONS          IN DOLLARS

    MONDAY......     298.55          3026.00
    TUESDAY.....     296.16          3043.15
    WEDNESDAY...     282.69          3016.87
    THURSDAY....     220.88          2324.62
    FRIDAY......     220.22          2354.15
    SATURDAY....     216.99          2269.40
```

TABLE 5-1G

```
23. NUMBER OF TRIPS BY TRAILERS
    TRAILER  71 MADE  13 TRIPS DURING WEEK.
    TRAILER  72 MADE  11 TRIPS DURING WEEK.
    TRAILER  73 MADE  11 TRIPS DURING WEEK.
    TRAILER  74 MADE  10 TRIPS DURING WEEK.
    TRAILER  75 MADE   3 TRIPS DURING WEEK.

24. NUMBER OF TRIPS BY TRACTORS
    TRACTOR  51 MADE  25 TRIPS DURING WEEK.
    TRACTOR  52 MADE  23 TRIPS DURING WEEK.

25. NUMBER OF TRACTORS GETTING  ONE
    HOUR OF OVERTIME DURING WEEK .......  3

26. NUMBER OF TRACTORS GETTING  TWO
    HOURS OF OVERTIME DURING WEEK ......  2

27. NUMBER OF TRACTORS GETTING MORE
    THAN TWO HOURS OF OVERTIME .........  0
```

TABLE 5-1H

LIMITATIONS

General limitations in a single run of Model 3 are:

(1) only one transfer station can exist, although its location can change with different runs.

(2) only one final disposal site can exist, although its location can change with different runs.

(3) only one size of collection truck and one size of haul trailer can exist, although the two sizes can be changed with different runs.

SIMULATED SYSTEMS

A single run of Model 3 can be made with one of three simulated systems; the decision as to which rests with the investigator. These are:

(1) Model 3A. Collection trucks make neighborhood collections and then take their loads to a final disposal site.

(2) Model 3B. Collection trucks make neighborhood collections and take their loads to a nearby transfer station with a sufficient number of unloading spaces so that there are no collection truck queues. Tractor-trailer rigs then carry the solid waste from the transfer station to the final disposal site.

(3) Model 3C. Collection trucks make neighborhood collections and take their loads to a nearby transfer station with two unloading spaces, so that at times queueing exists. Tractor-trailer rigs carry the solid waste from the transfer station to the final disposal site.

SEVEN POLICY DIVISIONS

The most important control exercised by the investigator is that of which these three systems will be simulated. Policy decisions must be made also for:

(1) The extent of urban area to be investigated:

This decision will normally be based on considerations other than model limitations. This report investigates the Northwest Division of the City of Baltimore, an area delineated by the Baltimore Bureau of Sanitation as one of four into which the City is divided, and the one from which collection is most expensive. Its area is approximately 20 square miles. The only constraints on size of the subject area in the model is that it must require no more than 50 collection trucks in the field per day; it must lend itself to division into no more than 25 subareas, each of constant neighborhood type; and no more than 10 tractors and 20 trailers must be required to operate from its transfer station.

(2) Frequency of Collection:

The model operates for either semiweekly or triweekly collection policy.

(3) The size of the collection trucks:

Any size truck may be used in the model; size is expressed in net loaded pounds, not cubic yardage. However the structure of the model generates a daily assignment of household units taken from Model 1 results for the larger 20 cubic yard trucks. The smaller 13 cubic yard trucks in general gave responses which indicated their assignment capability was about 0.85 to 0.95 of the larger trucks. Simulation runs with the smaller trucks must set the correction factor ASSUNK to 0.90 to reflect this reduced potential.

(4) The size and type of the transfer trailers:

The model will accept any capacity trailers; the system constraints are the state motor vehicle laws. The trailer length limitations appear to govern more often than weight limitations unless auxiliary compaction of the material is carried out at the transfer station.

(5) The transfer station site and routes between it and the subareas:

The model will accept any location within or beyond the urban area being investigated.

(6) The final disposal site and the routes to it:

In Model 3A, the collection trucks make the haul to the final disposal site. For this model, if the urban area is very large, i.e., of the order of 300,000 population, the site must be correspondingly close that no more than 50 collection trucks are required; also, the route for no truck can exceed a distance of 24 miles. In Models 3B and 3C, the tractor-trailer rigs make the haul to the final disposal site; for these models, there is no distance constraint other than that the site must be sufficiently close that no more than 20 trailers or 10 tractors are required for the transfer station operation.

(7) Overtime pay:

The user has the option of paying or not paying overtime.

SYSTEM DATA REQUIREMENTS

These seven operating decisions above complete the system's policy decisions. The investigator, in addition to the above, must use the values in the present program, or supply other more applicable data, for the following: Distributions which reflect collection rates in pounds per hour for different conditions of neighborhood type and days of accumulation of waste, collection trucks' dumping times, trailer dumping times, number of household per acre by neighborhood type, and pounds of waste generated per capita per day.

Regression equations of traffic velocity on traffic distance are in the model with coefficients of which can be changed in the data block. The standard error of estimate used with these equation can be changed also. Equations are present in the model which give as dependent variable the number of housing units to be assigned to collection trucks. The haul distances in miles are the independent variables, and three 2-dimensional matrices list the equation coefficients as functions of neighborhood types and collection frequency per week. These coefficient values can be changed in the data block if desired.

Also, values must be decided for data; the values used in the runs of this study are shown in parentheses.

(1) The average number of persons per housing unit for each neighborhood type; (2.7, 2.9, 3.1, 3.4)

(2) Amortization time period and interest rate for transfer station structures and appurtenances; (30 years and 10%)

(3) Capital investment in transfer station land; (varied with station size, but ranged from $40,000 to $80,000)

(4) Ratio of gross acreage to net acreage by neighborhood types; (1.3, 1.4, 1.6, 1.9)

(5) Hourly operating cost for collection trucks; ($4.40)

(6) Hourly operating cost for tractor-trailer rigs; ($11.00)

(7) Minimum off route time to be charged to truck crews: (50 minutes)

(8) Driver and laborer daily pay scales; ($20.00 and $18.00)

(9) Amount of tax revenue lost from city's use of transfer station land rather than private use of it; (none, as use was of land which would otherwise be park)

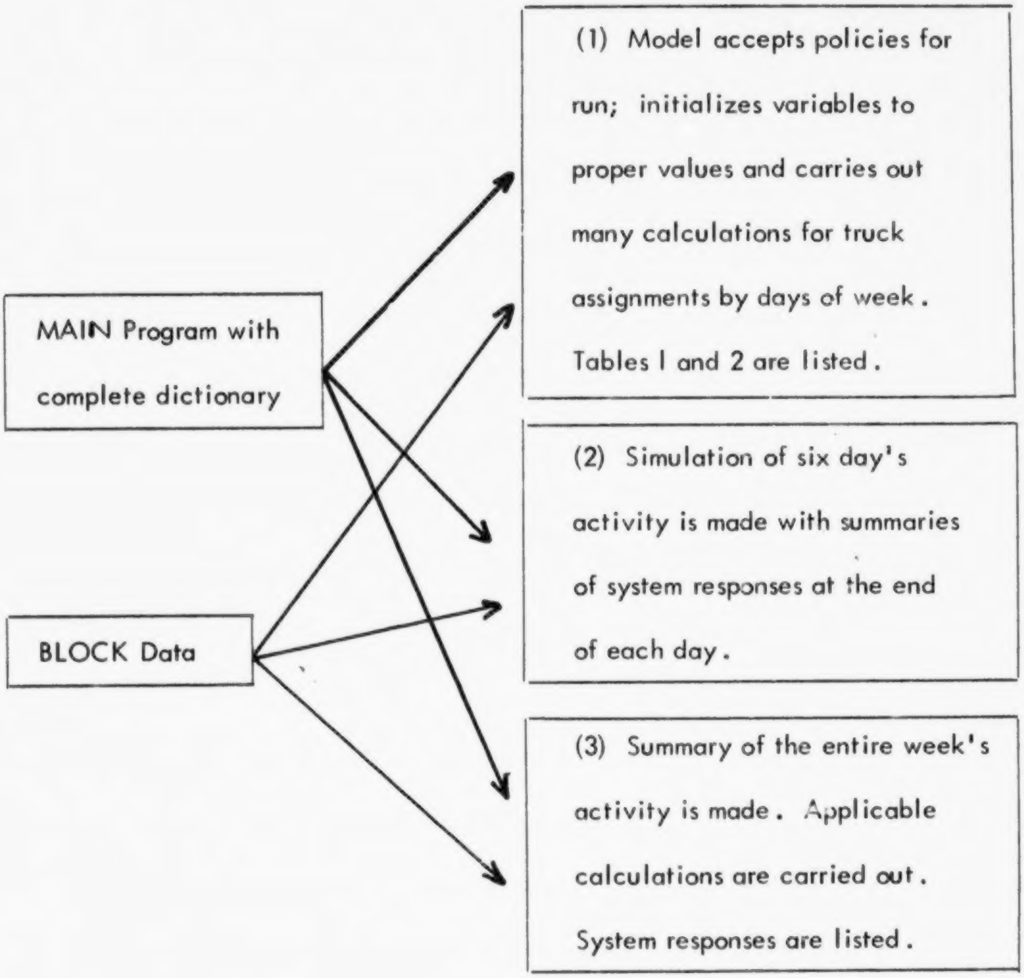
(10) Monthly utility cost of transfer station; ($100)

(11) The frequency of truck breakdowns or flat tires, and the off-route time to be charged in such event; (one every 1000 traffic miles)

STRUCTURE OF MODEL 3

The list of processing programs prepared by Dr. Mandell Bellmore again was used in this model. A MAIN program served as the focal point out of which the operating subroutines were called. The structure of the model may be thought of as being divided into three blocks as shown in Figure 5-1.

The dictionary in MAIN is in two parts, one for list processing terms, the other for the simulation variables. BLOCK DATA has been described in Chapter 3.


MAIN Program with complete dictionary
BLOCK Data

(1) Model accepts policies for run; initializes variables to proper values and carries out many calculations for truck assignments by days of week. Tables 1 and 2 are listed.

(2) Simulation of six day's activity is made with summaries of system responses at the end of each day.

(3) Summary of the entire week's activity is made. Applicable calculations are carried out. System responses are listed.

FIGURE 5-1. General Schematic of Model 3

Block 1 of Figure 5-1 serves as a necessary preface to the actual simulation of the weeks operations of solid waste collection and eventual transport to a final disposal site. Five subroutines are called by DRIVER. These read specific run data as which of the three systems is to be used, i.e., Model 3A, 3B, or 3C, collection frequency, etc.; the many variables are initialized to proper values; the traffic distances from the subareas are calculated; the number of households to be assigned to each truck each day of the week is calculated, and the total number of trucks for the system is found; trucks by number are assigned to routes in subareas by number for each day of the week. The daily cost of the transfer station is calculated. A paragraph which describes the conditions for which the run is being made is printed; Tables 1 and 2 are printed.

Block 2 of Figure 5-1 is structured within an "I=1, 6" loop, which for the six days of the week sequentially does the following:

(a) Calculates the route number for the trucks for the day of the week. If triweekly collection frequency is being simulated, Monday, Wednesday, and Friday work covers Route 1; Tuesday, Thursday, and Saturday work covers Route 2. Three routes per week exist for semiweekly collection.

(b) Calculates the total number of trucks to be fielded for the particular day. This is not constant throughout the week.

(c) Calls TIMER subroutine which, in turn, call subroutines which initialize to zero those variables which must be initialized at the beginning of each day, starts trucks on their tasks, and coordinates and records their activities until the day's end. TIMER also controls and records the activities at the transfer station. Finally Block 2 calculates the simulated costs of the day's operations.

Block 3 processes system's responses for the entire week by making necessary calculations and calling statistical subroutines. The latter includes formats and commands for result listing.

Figure 5-2 shows a more detailed interaction of the MAIN program with the subroutines. The three blocks of Figure 5-1 again are delineated. A discussion follows concerning individual subroutines positioned in Figure 5-2.

BLOCK 1 SUBROUTINES

(1) RUNDAT: Gives command to read run values for:

(a) COLFRE, collection frequency: may be 2 or 3.

(b) ASSSUN, value of 0. causes simulation of Model 3A;
value of l. causes simulation of Model 3B;
value of 2. causes simulation of Model 3C.

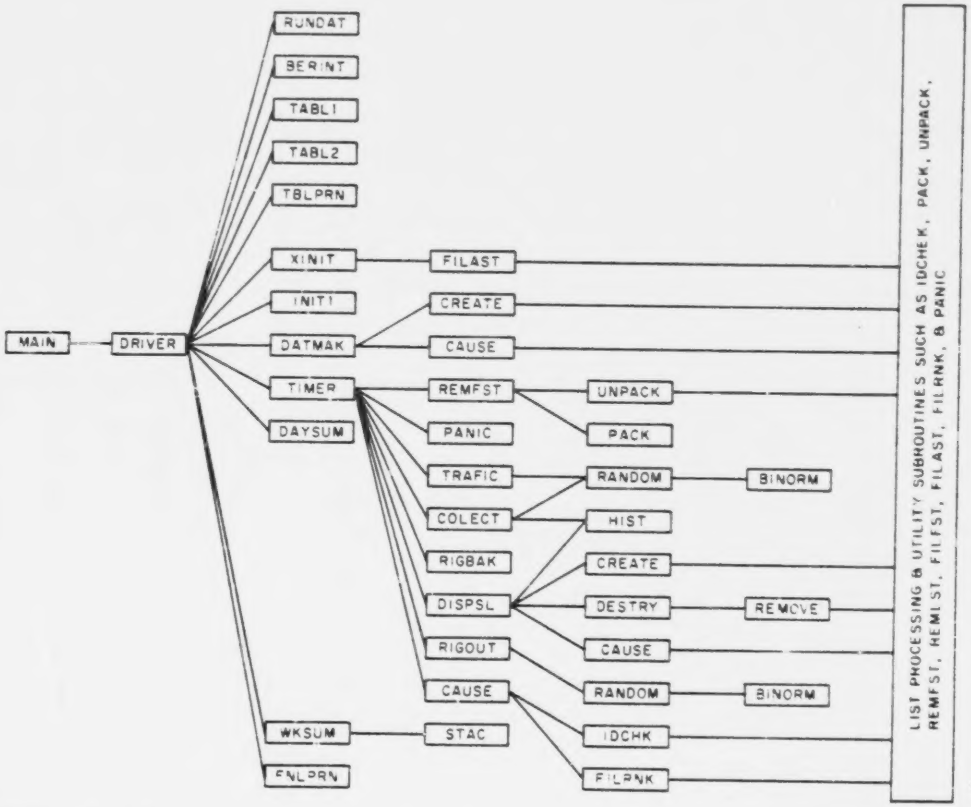

MAIN
DRIVER
RUNDAT
BERINT
TABL1
TABL2
TBLPRN
XINIT
INIT1
DATMAK
TIMER
DAYSUM
WKSUM
FNLPRN
FILAST
CREATE
CAUSE
REMFST
PANIC
TRAFIC
COLECT
RIGBAK
DISPSL
RIGOUT
CAUSE
STAC
UNPACK
PACK
RANDOM
HIST
CREATE
DESTRY
CAUSE
RANDOM
IDCHK
FILRNK
BINORM
REMOVE
BINORM
LIST PROCESSING & UTILITY SUBROUTINES SUCH AS IDCHEK, PACK, UNPACK, REMFST, REMLST, FILFST, FILAST, FILRNK, & PANIC

FIGURE 5 - 2

Interaction of Model 3 Subroutines

(c) ASSUNK, a control variable: normally equal to one. The number of household units assigned to any truck is equal to the product of ASSUNK and the number of household units generated by the regression equations.

(d) TRLHAL: the distance from transfer station to final disposal site in miles.

(e) RUNNO: run number.

(f) K: random number generator seed.

(g) NOTRC: number of tractors at transfer station if given a value of a positive integer; if given a value of zero, the program calculates a NOTRC value from a deterministic equation which has trailer haul distance, collection frequency, trailer capacity, population served, and average weight generated per day per person as independent variables.

(h) Q9, a control variable, when equal to zero no overtime is paid to collection truck crews; when equal to one, overtime is paid.

(i) Q10, a control variable which is set equal to 1 if collection truck traffic distance is to be calculated from coordinates. If Model 3A is being run, it may be set equal to zero which will set all collection truck traffic distances equal to a constant value e.g., TRLHAL.

(2) ZERINT: Initializes most variable values to zero; sets all tractors to "idle and empty" status; puts first trailer in "being loaded" status.

(3) TABL 1: Calculates haul distances from each subarea to the collection truck's dumping destination, and calculates number of households which comprise a daily truck task for each of the subareas. Calculates the number of truck routes in each subarea.

(4) TABL 2: Calculates total number of collection trucks in the model; assigns trucks by number to areas by number for each day of the week; calculates each truck's attributes of haul distance, neighborhood type, and size of assigned task; calculates size, capital investment, and number in labor force at transfer station; calculates daily cost of transfer station from the sum of the following costs: labor, land, utilities, appurtenances and structures, and loss from tax revenue not realized.

(5) TBLPRN: Gives formats and commands for printing lead paragraph which describes the system being simulated and formats and commands for Tables 1 and 2. Table 1 lists the subareas and their attributes. Table 2 lists each truck and its attributes such as assignments, haul distances, subarea in which it is to work, etc., by days of the week.

BLOCK 2 SUBROUTINES

Many of these are list processing or utility types and serve the identical function in Model 3 as they did in Models 1 and 2. Reference is made to Chapter 3 in which descriptions are given of the following subroutines common to all three models: TIMER, CAUSE, CREATE, FILFST, FILAST, FILRNK, IDCHK, PACK, REMFST, UNPACK, CLOCK, HIST, RANDOM, RANDER, and SSWTCH. Subroutine STAC is identical with Model 2 STAT.

(1) DAYSUM: Calculates separately each day's costs of collection trucks activities and of transfer station tractor-trailer operations.

(2) XINIT: Initializes list processing variables to proper values.

(3) INIT1: Initializes to zero each morning those simulation variables which have had their values changed during the preceding day's operation.

(4) DATMAK: Fields the trucks at the beginning of each day and records their movement into traffic in the list processing subroutines.

(5) TRAFIC: Records each collection truck's accumulative time and distance in traffic, both to and from the collection area. Possibility of flat tires and breakdown is included.

(6) COLECT: Generates number of miles that each truck covers while collecting; generates a different collection rate for crew for each

trip to collection neighborhood; generates total weight to be collected by each truck for each day; notes when day's task is finished for each truck, and accumulates total time spent in collection.

(7) RIGOUT: Counts number of trips for trailer-tractor rigs, for trailers separately, and for tractors separately; generates dumping time at final disposal site from a normal distribution; generates traffic speeds and elapsed times in traffic both to and from final disposal site; records actual operating time of rigs for cost calculations.

(8) RIGBAK: Checks and records when trailer-tractor rigs are on overtime; determines if a full trailer awaits the returning tractor, and if so, combines them and dispatches them.

(9) DISPSL: Notes whether Model 3A, 3B, or 3C is being simulated; generates dumping time from histogram; directs truck to shorter of the two queues when applicable; records total number of collection truck trips; notes if trailer becomes full and replaces it with an empty one when applicable; dispatches full trailer to disposal site if tractor is available, otherwise sets its status to "idle and full", notes overtime for collection trucks at end of day, notes when quitting time permits truck servicing and records off-route time for this activity.

BLOCK 3 SUBROUTINE

(1) WEEKSM: Sums the six days of collection truck's costs to give the week's total; sums the six days of transfer station trailer-tractor costs to give the week's total; calls statistical routines for calculations of desired output; summarizes queueing operations.

(2) FNLPRN: Lists formats and commands, switching as needed for Models 3A, 3B, and 3C.

LOGIC FLOW CHARTS

Five subroutines of prototype activities have been described; they are TRAFIC, COLECT, DISPSL, RIGOUT, RIGBAK. Their logic flow charts are presented in Figures 5-3 through 5-7.

MISCELLANEOUS ASSUMPTIONS LIMITATIONS, AND COMMENTS ON MODEL THREE

(1) Collection frequencies other than semiweekly or triweekly cannot be simulated on the model; this reduces its general applicability as simulation of once-weekly or daily systems are eliminated.

(2) In TRAFIC and RIGOUT subroutines, the truck and tractor speeds are drawn from a normal distribution which has as mean a value taken from a regression equation of log speeds on trip distances. The coefficients of these equations and the standard deviations of the distribution can be changed by changing their values on data cards. Maximum and minimum values for these speeds can be varied equally easily. The form of the equation is within the program however, and coding change would be necessary if another type of equation is desired.

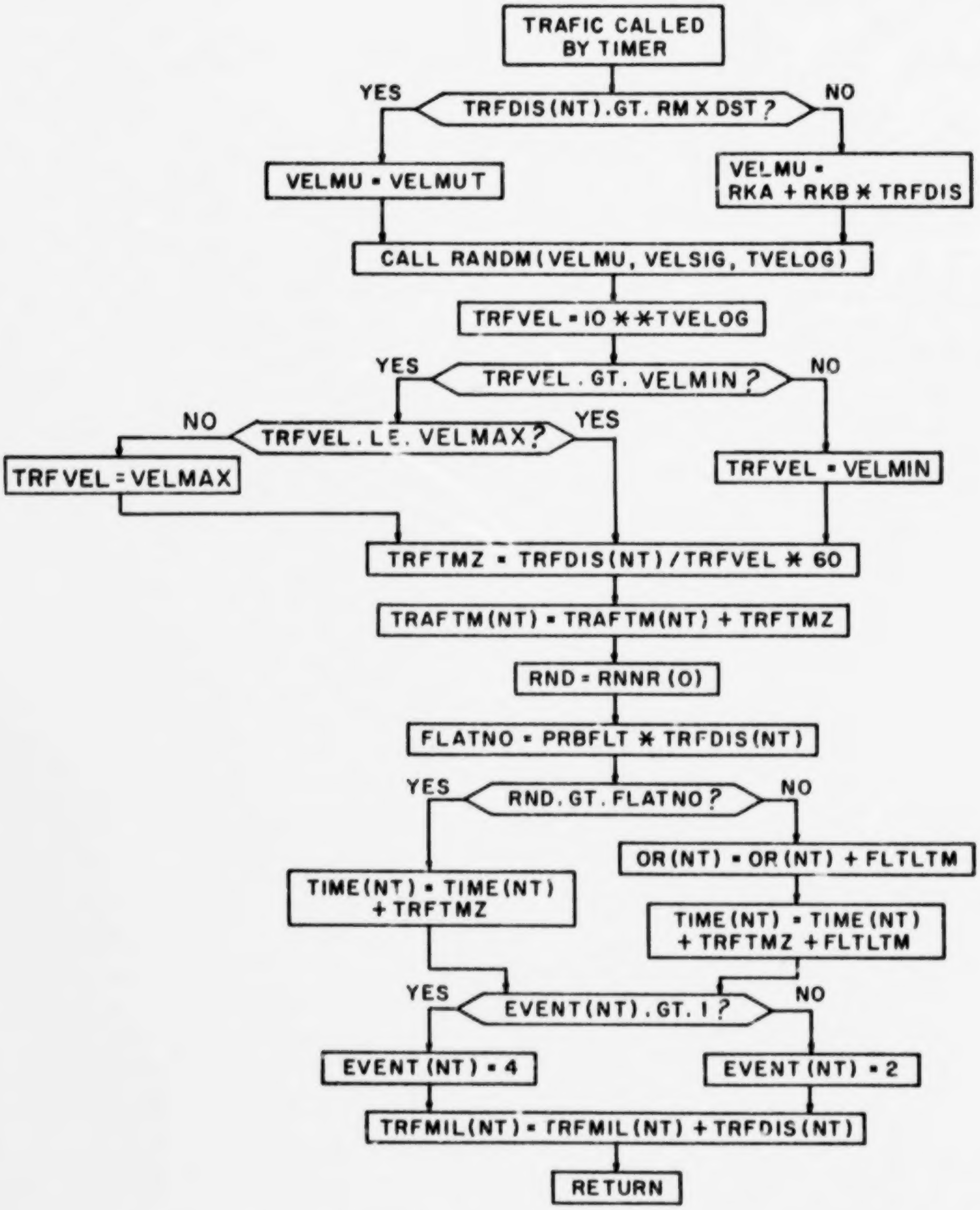

TRAFIC CALLED BY TIMER
YES
TRFDIS(NT).GT. RM X DST ?
NO
VELMU = VELMUT
VELMU = RKA + RKB ✱ TRFDIS
CALL RANDM(VELMU, VELSIG, TVELOG)
TRFVEL = 10 ✱✱TVELOG
YES
TRFVEL . GT. VELMIN ?
NO
NO
TRFVEL. LE. VELMAX?
YES
TRFVEL = VELMAX
TRFVEL = VELMIN
TRFTMZ = TRFDIS(NT)/TRFVEL ✱ 60
TRAFTM(NT) = TRAFTM(NT) + TRFTMZ
RND = RNNR (0)
FLATNO = PRBFLT ✱ TRFDIS(NT)
YES
RND. GT. FLATNO ?
NO
OR(NT) = OR(NT) + FLTLTM
TIME(NT) = TIME(NT) + TRFTMZ
TIME(NT) = TIME(NT) + TRFTMZ + FLTLTM
YES
EVENT(NT). GT. 1 ?
NO
EVENT(NT) = 4
EVENT(NT) = 2
TRFMIL(NT) = TRFMIL(NT) + TRFDIS(NT)
RETURN

FIGURE 5 - 3

Subroutine TRAFIC, Model 3

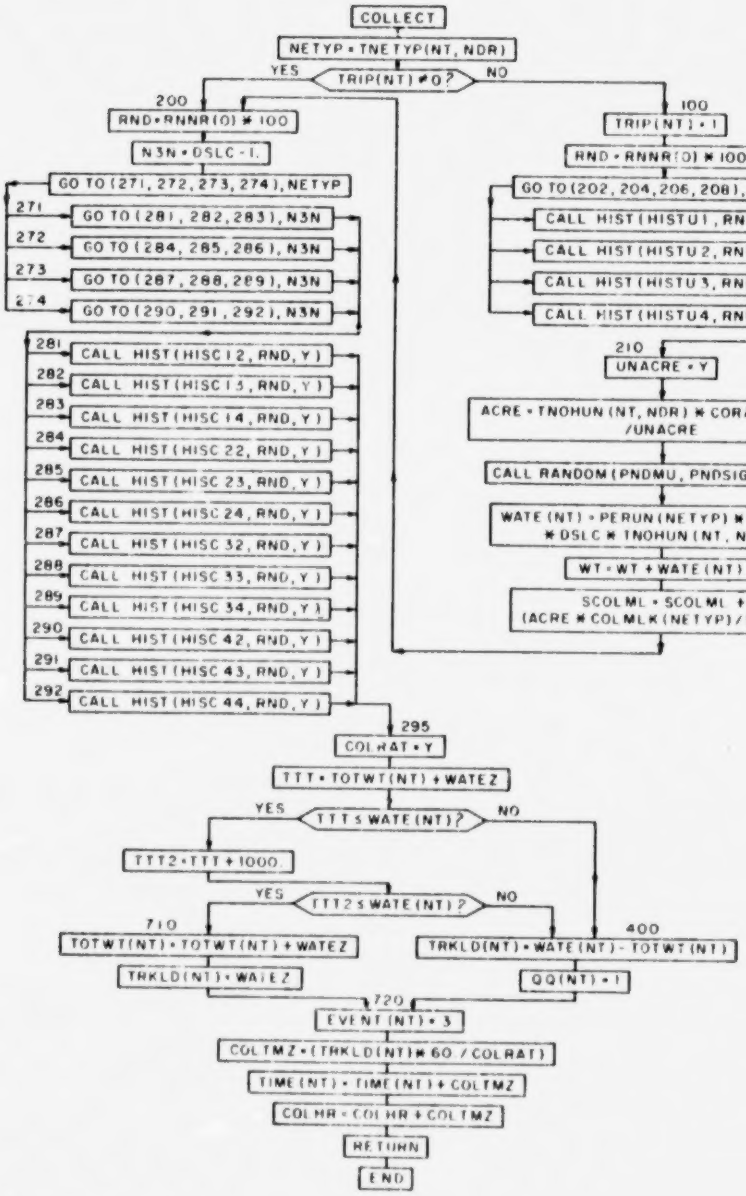

COLLECT
NETYP = TNETYP(NT, NDR)
TRIP(NT) ≠ 0?
YES
NO
200
RND = RNNR(0) * 100
N3N = DSLC - 1.
GO TO (271, 272, 273, 274), NETYP
271 GO TO (281, 282, 283), N3N
272 GO TO (284, 285, 286), N3N
273 GO TO (287, 288, 289), N3N
274 GO TO (290, 291, 292), N3N
281 CALL HIST(HISC12, RND, Y)
282 CALL HIST(HISC13, RND, Y)
283 CALL HIST(HISC14, RND, Y)
284 CALL HIST(HISC22, RND, Y)
285 CALL HIST(HISC23, RND, Y)
286 CALL HIST(HISC24, RND, Y)
287 CALL HIST(HISC32, RND, Y)
288 CALL HIST(HISC33, RND, Y)
289 CALL HIST(HISC34, RND, Y)
290 CALL HIST(HISC42, RND, Y)
291 CALL HIST(HISC43, RND, Y)
292 CALL HIST(HISC44, RND, Y)
100
TRIP(NT) = 1
RND = RNNR(0) * 100.
GO TO (202, 204, 206, 208), NETYP
CALL HIST(HISTU1, RND, Y)
CALL HIST(HISTU2, RND, Y)
CALL HIST(HISTU3, RND, Y)
CALL HIST(HISTU4, RND, Y)
210
UNACRE = Y
ACRE = TNOHUN(NT, NDR) * CORACR(NETYP) /UNACRE
CALL RANDOM(PNDMU, PNDSIG, PNDPER)
WATE(NT) = PERUN(NETYP) * PNDPER * DSLC * TNOHUN(NT, NDR)
WT = WT + WATE(NT)
SCOLML = SCOLML + (ACRE * COLMLK(NETYP)/5280.)
295
COLRAT = Y
TTT = TOTWT(NT) + WATEZ
TTT ≤ WATE(NT)?
YES
NO
TTT2 = TTT + 1000.
TTT2 ≤ WATE(NT)?
YES
NO
710
TOTWT(NT) = TOTWT(NT) + WATEZ
TRKLD(NT) = WATEZ
400
TRKLD(NT) = WATE(NT) - TOTWT(NT)
QQ(NT) = 1
720
EVENT(NT) = 3
COLTMZ = (TRKLD(NT) * 60./COLRAT)
TIME(NT) = TIME(NT) + COLTMZ
COLHR = COLHR + COLTMZ
RETURN
END

FIGURE 5 - 4

Subroutine COLECT, Model 3

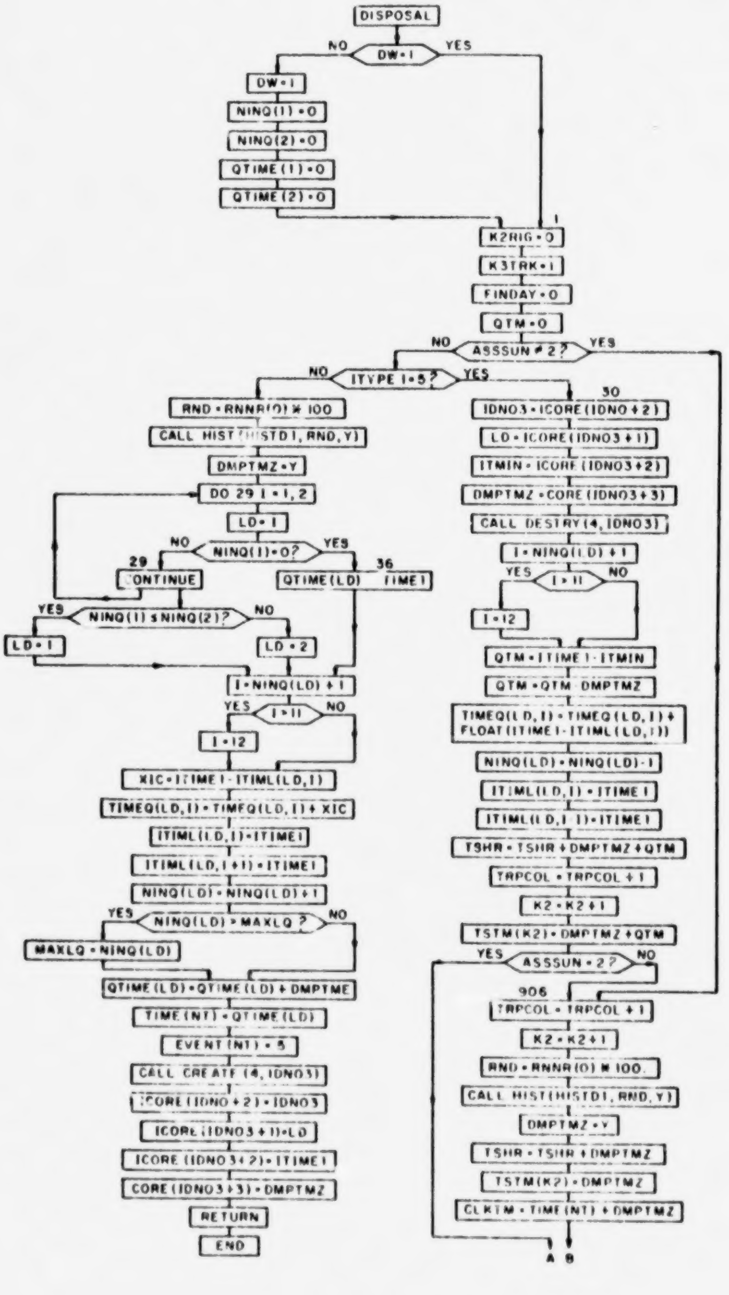

DISPOSAL
NO
DW = 1
YES
DW = 1
NINQ(1) = 0
NINQ(2) = 0
QTIME(1) = 0
QTIME(2) = 0
1
K2RIG = 0
K3TRK = 1
FINDAY = 0
QTM = 0
NO
ASSSUN ≠ 2?
YES
NO
ITYPE1 = 5?
YES
RND = RNNR(0) * 100
CALL HIST(HISTD1, RND, Y)
DMPTMZ = Y
DO 29 I = 1, 2
LD = 1
NO
NINQ(I) = 0?
YES
29
CONTINUE
36
QTIME(LD) ITIME1
YES
NINQ(1) ≤ NINQ(2)?
NO
LD = 1
LD = 2
I = NINQ(LD) + 1
YES
I > 11
NO
I = 12
XIC = ITIME1 - ITIML(LD,I)
TIMEQ(LD,I) = TIMEQ(LD,I) + XIC
ITIML(LD,I) = ITIME1
ITIML(LD,I+1) = ITIME1
NINQ(LD) = NINQ(LD) + 1
YES
NINQ(LD) > MAXLQ ?
NO
MAXLQ = NINQ(LD)
QTIME(LD) = QTIME(LD) + DMPTME
TIME(NT) = QTIME(LD)
EVENT(NT) = 5
CALL CREATE (4, IDNO3)
ICORE(IDNO+2) = IDNO3
ICORE(IDNO3+1) = LD
ICORE(IDNO3+2) = ITIME1
CORE(IDNO3+3) = DMPTMZ
RETURN
END
30
IDNO3 = ICORE(IDNO+2)
LD = ICORE(IDNO3+1)
ITMIN = ICORE(IDNO3+2)
DMPTMZ = CORE(IDNO3+3)
CALL DESTRY(4, IDNO3)
I = NINQ(LD) + 1
YES
I > 11
NO
I = 12
QTM = ITIME1 - ITMIN
QTM = QTM DMPTMZ
TIMEQ(LD,I) = TIMEQ(LD,I) + FLOAT(ITIME1 - ITIML(LD,I))
NINQ(LD) = NINQ(LD) - 1
ITIML(LD,I) = ITIME1
ITIML(LD,I-1) = ITIME1
TSHR = TSHR + DMPTMZ + QTM
TRPCOL = TRPCOL + 1
K2 = K2 + 1
TSTM(K2) = DMPTMZ + QTM
YES
ASSSUN = 2?
NO
906
TRPCOL = TRPCOL + 1
K2 = K2 + 1
RND = RNNR(0) * 100.
CALL HIST(HISTD1, RND, Y)
DMPTMZ = Y
TSHR = TSHR + DMPTMZ
TSTM(K2) = DMPTMZ
CLKTM = TIME(NT) + DMPTMZ
A
B

FIGURE 5 - 5A, Subroutine DSPOSL, Model 3

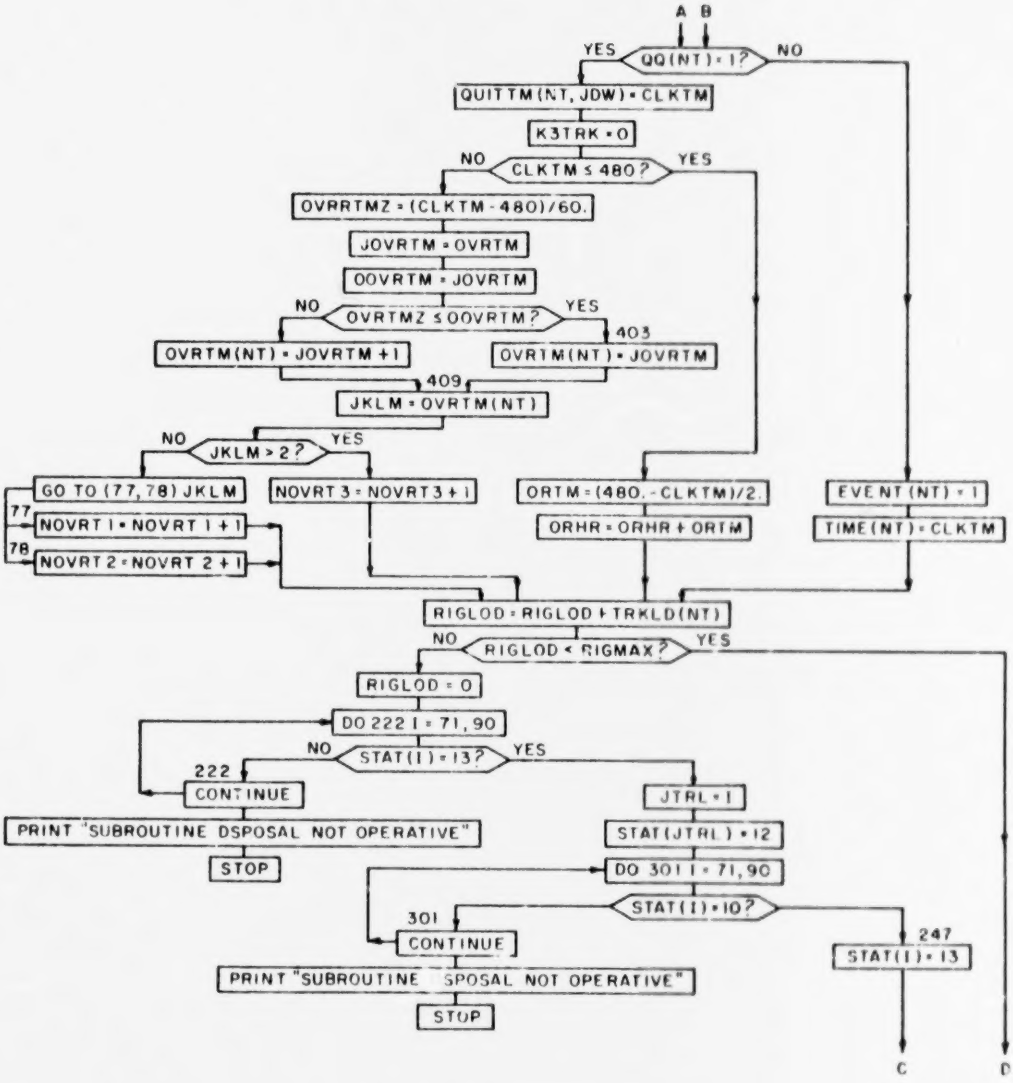

A
B
YES
QQ(NT) = 1?
NO
QUITTM(NT, JDW) = CLKTM
K3TRK = 0
NO
CLKTM ≤ 480?
YES
OVRRTMZ = (CLKTM - 480)/60.
JOVRTM = OVRTM
OOVRTM = JOVRTM
NO
OVRTMZ ≤ OOVRTM?
YES
403
OVRTM(NT) = JOVRTM + 1
OVRTM(NT) = JOVRTM
409
JKLM = OVRTM(NT)
NO
JKLM > 2?
YES
GO TO (77, 78) JKLM
NOVRT3 = NOVRT3 + 1
ORTM = (480. - CLKTM)/2.
EVENT(NT) = 1
77
NOVRT1 = NOVRT1 + 1
ORHR = ORHR + ORTM
TIME(NT) = CLKTM
78
NOVRT2 = NOVRT2 + 1
RIGLOD = RIGLOD + TRKLD(NT)
NO
RIGLOD < RIGMAX?
YES
RIGLOD = 0
DO 222 I = 71, 90
NO
STAT(I) = 13?
YES
222
CONTINUE
JTRL = 1
PRINT "SUBROUTINE DSPOSAL NOT OPERATIVE"
STAT(JTRL) = 12
STOP
DO 301 I = 71, 90
STAT(I) = 10?
301
CONTINUE
247
STAT(I) = 13
PRINT "SUBROUTINE SPOSAL NOT OPERATIVE"
STOP
C
D

FIGURE 5 - 5B

Subroutine DSPOSL, Model 3

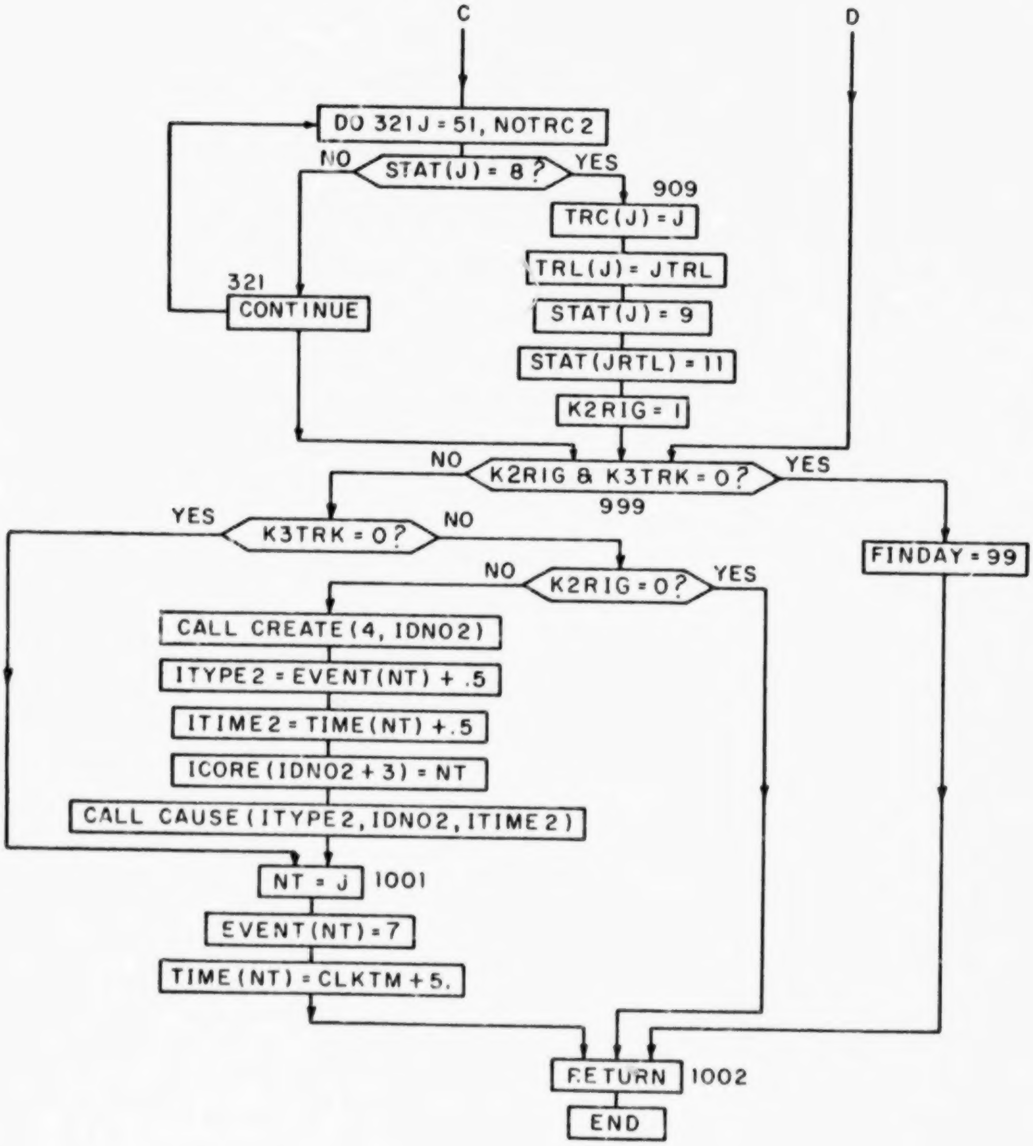

C
D
DO 321 J = 51, NOTRC 2
NO
STAT(J) = 8 ?
YES
909
TRC(J) = J
TRL(J) = JTRL
321
CONTINUE
STAT(J) = 9
STAT(JRTL) = 11
K2RIG = 1
NO
K2RIG & K3TRK = 0?
YES
999
YES
K3TRK = 0?
NO
FINDAY = 99
NO
K2RIG = 0?
YES
CALL CREATE (4, IDNO2)
ITYPE2 = EVENT(NT) + .5
ITIME2 = TIME(NT) + .5
ICORE (IDNO2 + 3) = NT
CALL CAUSE (ITYPE2, IDNO2, ITIME2)
NT = J
1001
EVENT(NT) = 7
TIME (NT) = CLKTM + 5.
RETURN
1002
END

FIGURE 5 - 5C

Subroutine DSPOSL, Model 3

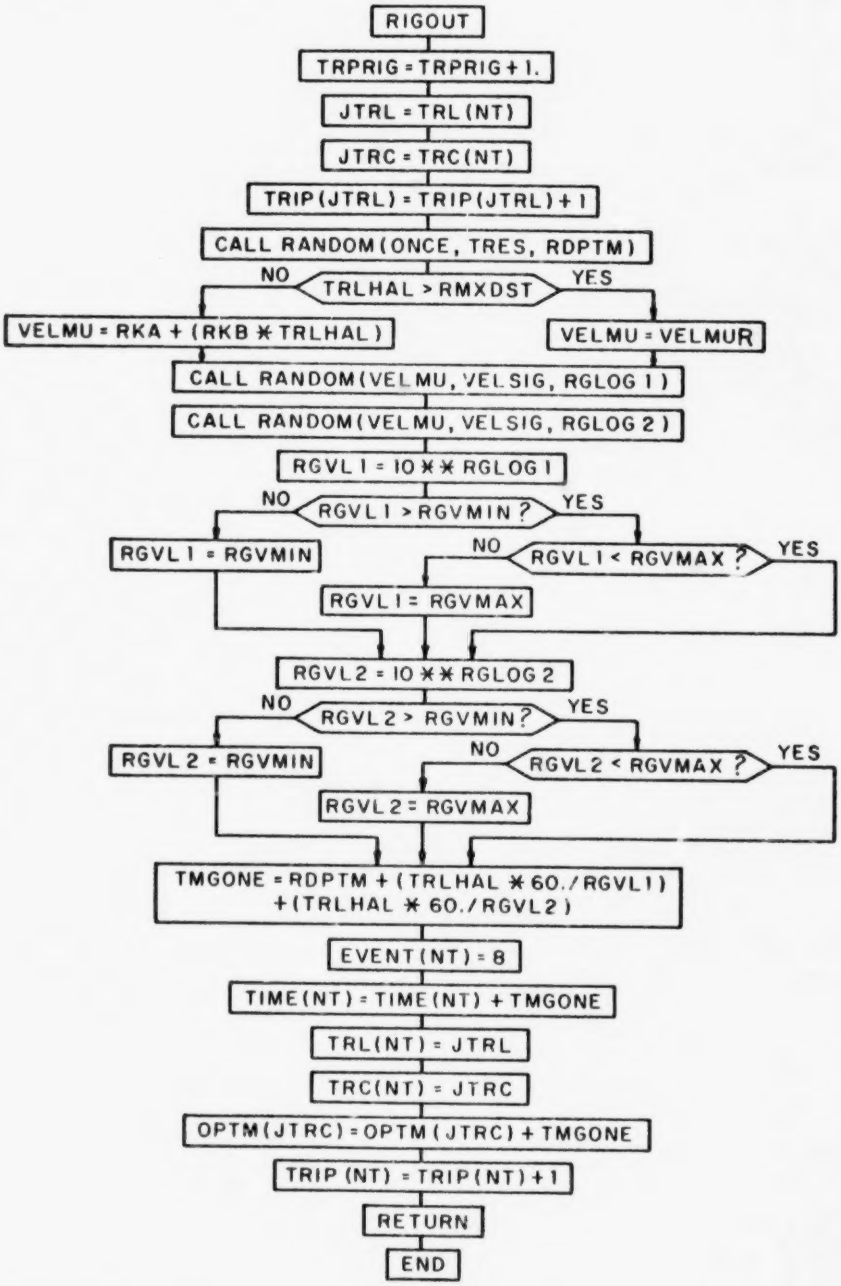

RIGOUT
TRPRIG = TRPRIG + 1.
JTRL = TRL(NT)
JTRC = TRC(NT)
TRIP(JTRL) = TRIP(JTRL) + 1
CALL RANDOM(ONCE, TRES, RDPTM)
NO
TRLHAL > RMXDST
YES
VELMU = RKA + (RKB * TRLHAL)
VELMU = VELMUR
CALL RANDOM(VELMU, VELSIG, RGLOG 1)
CALL RANDOM(VELMU, VELSIG, RGLOG 2)
RGVL 1 = 10 ** RGLOG 1
NO
RGVL 1 > RGVMIN ?
YES
RGVL 1 = RGVMIN
NO
RGVL 1 < RGVMAX ?
YES
RGVL 1 = RGVMAX
RGVL 2 = 10 ** RGLOG 2
NO
RGVL 2 > RGVMIN ?
YES
RGVL 2 = RGVMIN
NO
RGVL 2 < RGVMAX ?
YES
RGVL 2 = RGVMAX
TMGONE = RDPTM + (TRLHAL * 60./RGVL1) + (TRLHAL * 60./RGVL2)
EVENT(NT) = 8
TIME(NT) = TIME(NT) + TMGONE
TRL(NT) = JTRL
TRC(NT) = JTRC
OPTM(JTRC) = OPTM(JTRC) + TMGONE
TRIP(NT) = TRIP(NT) + 1
RETURN
END

FIGURE 5 - 6

Subroutine RIGOUT, Model 3

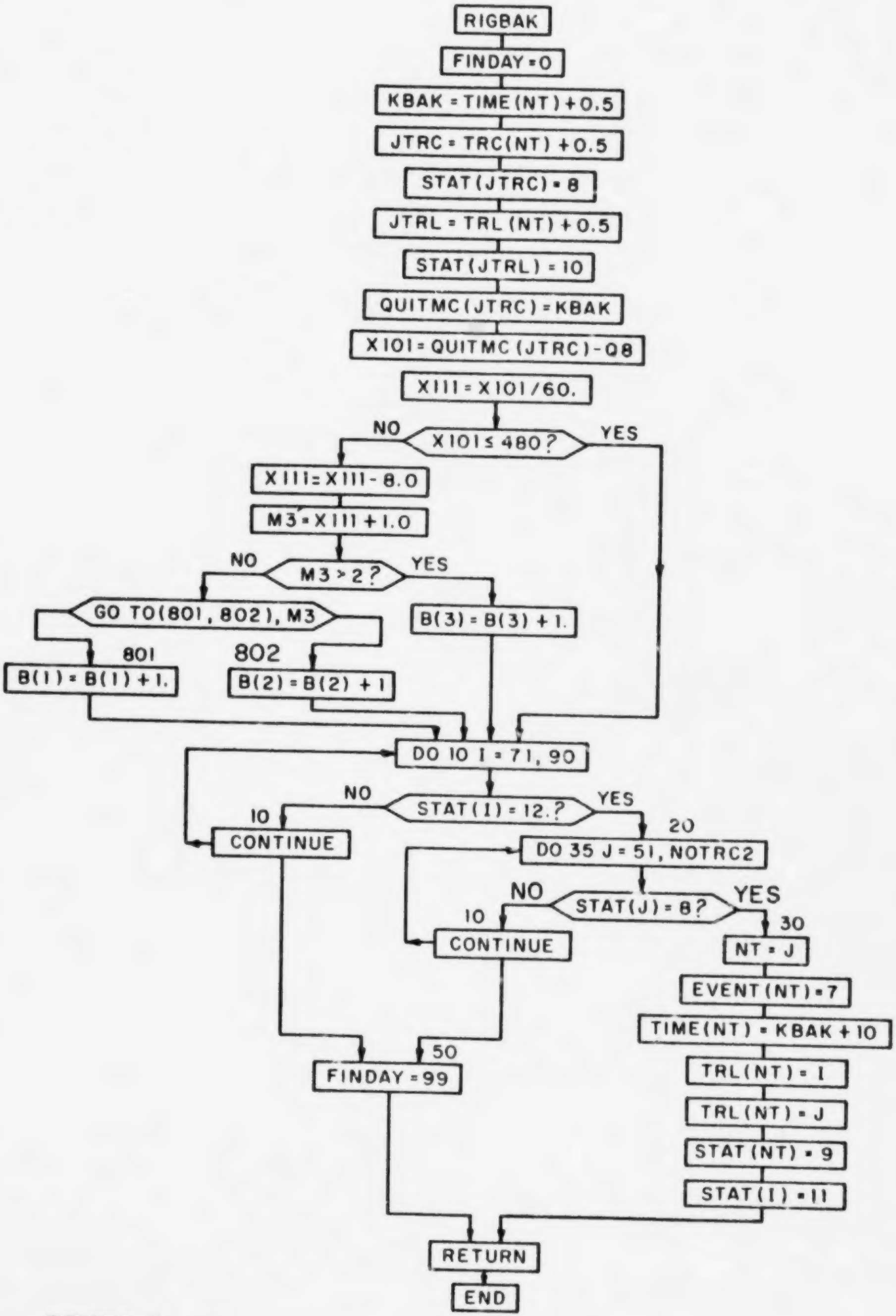

RIGBAK
FINDAY = 0
KBAK = TIME (NT) + 0.5
JTRC = TRC(NT) + 0.5
STAT (JTRC) = 8
JTRL = TRL (NT) + 0.5
STAT (JTRL) = 10
QUITMC (JTRC) = KBAK
X101 = QUITMC (JTRC) - Q8
X111 = X101/60.
NO
X101 ≤ 480?
YES
X111 = X111 - 8.0
M3 = X111 + 1.0
NO
M3 > 2?
YES
GO TO (801, 802), M3
B(3) = B(3) + 1.
801
802
B(1) = B(1) + 1.
B(2) = B(2) + 1
DO 10 I = 71, 90
NO
STAT (I) = 12.?
YES
10
CONTINUE
20
DO 35 J = 51, NOTRC2
NO
STAT (J) = 8?
YES
10
CONTINUE
30
NT = J
EVENT (NT) = 7
TIME (NT) = KBAK + 10
TRL (NT) = I
TRL (NT) = J
STAT (NT) = 9
STAT (I) = 11
50
FINDAY = 99
RETURN
END

FIGURE 5 - 7

Subroutine RIGBAK, Model 3

(3) In COLECT subroutine, the assumption is made that the collection truck returns to disposal site or transfer station only when a particular truck capacity has been exceeded or when the loaded weight, even though less than capacity, completes the day's assignment. Thus Model 3 assumes a greater efficiency in system operations than did Model I which, based on field observations, drew from a histogram to determine "loaded weight".

(4) In RIGOUT subroutine, the time spent by the trailer-tractor rig at the final disposal site is drawn randomly from a normal distribution based on field data for such rigs. The distribution parameters may be changed easily with data cards, but program coding changes would be required to change the type of distribution.

(5) An empirical equation for setting the number of tractors at the transfer station is in RUNDAT. If NOTRC is set to zero on the run data tape, the equation is used; if NOTRC is set equal to any positive integer, the program by-passes the equation, and the number of tractors at the transfer station is that value given NOTRC. The equation is discussed below:

Let N = number of tractors needed.

NL = maximum number of trailer loads per day transported to disposal site.

LPTPD = loads per tractor per day.

SUMUNIT = total number of household in the complete area under study.

AVP = approximate number of persons per household.

COLFRE = collection frequency per week.

DSLC = maximum days since last collection; 4 if COLFRE = 2, 3 if COLFRE = 3.

RIGMAX = pounds capacity of trailer.

TRLHAL = one way distance in miles between transfer station and disposal site.

The equation development follows:

(a) $\mathrm{N} = \mathrm{NL}/\mathrm{LPTPD}$

where $$\mathrm{NL} = \frac{\mathrm{SUMUNIT} * \mathrm{COLFRE} * \mathrm{PNDMU} * \mathrm{DSLC} * \mathrm{AVP}}{6 * \mathrm{RIGMAX}}$$

and $\mathrm{LPTPD} = 6.9 - (0.1 * \mathrm{TRLHAL})$.

This latter equation approximates the number of trips possible per day for a tractor; it is deterministic using average speeds and average time at disposal site. It is for a no-overtime day.

Equation (a) is thus:

$$\mathrm{N} = \frac{\mathrm{SUMUNIT} * \mathrm{COLFRE} * \mathrm{PNDMU} * \mathrm{DSLC} * \mathrm{AVP} * 10.}{6. * \mathrm{RIGMAX} * (69. - \mathrm{TRLHAL})}$$

The value of N is integer. The coding constrains the answers between 2 and 10 inclusive; the former as it is believed that proper planning would require more than one tractor regardless of the smallness of the station; the latter because of model limitations.

(6) The number of trailers assigned to the transfer station is determined only by the need. The program calls additional trailers as needed up to a limit of twenty, beyond which the model is inoperative. Successive runs under constant conditions may require different numbers of trailers because of stochastic influences.

(7) Production runs in this study were made on a particular quadrant of Baltimore city. The description of this tract is in format statement 8022 of TBLPRN subroutine. If the investigator wishes to incorporate a description of his tract, the proper description format should replace the existing 8022 statement, but should retain the number. If no such description is needed in output, the card commanding this format, "WRITE (IOU, 8022)", line number 2210 of TBLPRN, should be removed.

(8) If auxiliary compacting apparatus is to be simulated at the transfer station, two card changes are needed in the data: RIGMAX must be

changed to reflect the increased trailer load and COMPAP must be changed from a value of zero to a dollar value of the material cost plus the installation cost of the compacting apparatus.

(9) Subroutine TABL1 calculates collection trucks' haul distance from a subarea (I) either to the transfer station, when it exists, or to the final disposal site. The program coding is such that one of three distances may be used at the option of the user. These are:

(1) A linear distance along a well traveled thoroughfare which would be used regularly from the population centroid of the subarea to the dumping site. Its length in feet is entered in data as ROADIS(I).

(2) No such thoroughfare may exist, and the user may believe that trucks from the subarea will travel many different routes to and from dumping, all within the framework of a city's rectangular street system. In this case, ROADIS(I) is set to zero. AX1(I), AX2(I), AY1(I), and AY2(I) are given values other than zero, and the subroutine calculates haul distance from the equation

ABS [AX1(I) - AX2(I)] + ABS [AY1(I) - AY2(I)].

In the above, AX1(I) and AY1(I) are the population centroids of subarea (I) in a rectangular grid of the urban area. AX2(I) and AY2(I) are grid coordinates of the dumping site. This $[\Delta X + \Delta Y]$ is often used for travel distance in city planning; it is termed the "metric L". The units of the grid are feet.

(3) The user may assume truck movement along part of the route by metric L path and part along a defined measurable path. In this case, an equation incorporating both distances is used. Table 6-1 illustrates data for Model 3 runs for all three procedures.

The equation in subroutine TABL1 which generates the assignment of number of households is:

$$X_1(I) = C_1 + [C_2 * X_2(I)] + [C_3 * X_2(I)^2]$$

in which:

1. $X_1(I)$ is the number of household units from a subarea (I) which constitute a single truck's daily collection assignment.
2. $X_2(I)$ is haul distance from subarea(I) to the dumping site.
3. C_1, C_2, and C_3 are equation coefficients obtained from three matrices of values, C_{ij} in which "i" is neighborhood type, and "j" is collection frequency. These values are from regressions using Model 1 responses.

(10) Subroutine TABL2 calculates total capital investment in the transfer station by summing land value and cost of structures and appurtenances. The transfer station expense is reflected in interest charges on the land value, by depreciation charge on the structure and appurtenances, by loss of tax income from the land when applicable, by utility charges, and by station labor expense. In the discussion below, the program coding variables and their values in this study are given.

The land values are as shown below. Station capacity in tons per day is "C".

When	Land value
$C \leq 200$	CONA
$C > 200$	C * CONF

CONA = \$40,000

CONF = \$200/ton

The cost of structures and appurtenances are as shown below.

When	Cost of structures and appurtenances
$C \leq 100$	COND
$C > 100$	CONB + (C * CONE)

COND = \$125,000

CONB = \$ 75,000

CONE = \$500/ton

The cost of auxiliary compaction equipment is added to the cost of the structures and appurtenances. This variable, COMPAP, has a value of $150,000 in this study when this apparatus is in use. The value will be zero for all users when the apparatus is not in the system.

The depreciation term, YRS, has a value of 30 years. The interest rate variable, R, is 10% both for land investment interest and for structure amortization. This reflects a rate of return proper for other public benefits which remained unbuilt rather than reflecting municipal bond rates.

A three man crew is assigned to the transfer station when capacity is below 200 tons per day; a four man crew when greater.

CHAPTER 6: RESULTS FROM MODEL 3

Model 2's great limitation is that the urban area being investigated must be of constant neighborhood density. Model 3 does not have this limitation and can investigate model responses from simulated systems in actual urban areas composed of tracts of different neighborhood types. This study has used the northwest quadrant of Baltimore city for its investigation. The area has approximately 75,000 housing units, 225,000 population, and was divided for this study into thirteen subareas, each of a particular neighborhood type.

Figure 6-1 is a sketch of this portion of Baltimore; the divisions into the subareas and the simulated location of the transfer station are shown. Table 6-1 tabulates the properties of the subareas gathered by the investigator as first step in using Model 3. The information in Table 6-1 was given to the model, which then processed it and used it as basis for calculations for number of needed collection trucks and in their assignments to subarea routes. Thirty-one runs were made with Model 3 for this study. The tabulation of the policies and environmental conditions of the runs is presented in Table 6-2. The runs were made for investigation of the following:

1. Proving the model
2. Noting model responses to interactions of varying collection frequencies and haul distances with and without transfer station.
3. Determination of critical distances beyond which the use of a transfer station is economically feasible.
4. Cost of increasing collection in the area to triweekly frequency with haul to present incinerators.
5. Effect on cost of auxiliary compacting equipment at transfer station.
6. Sensitivity of costs to number of transfer station unloading docks.
7. Sensitivity of costs to number of transfer stations in the area.
8. Sensitivity of costs to tractor-trailer ratios.
9. Sensitivity of model responses to different random number sequences.

The results of the investigation follow.

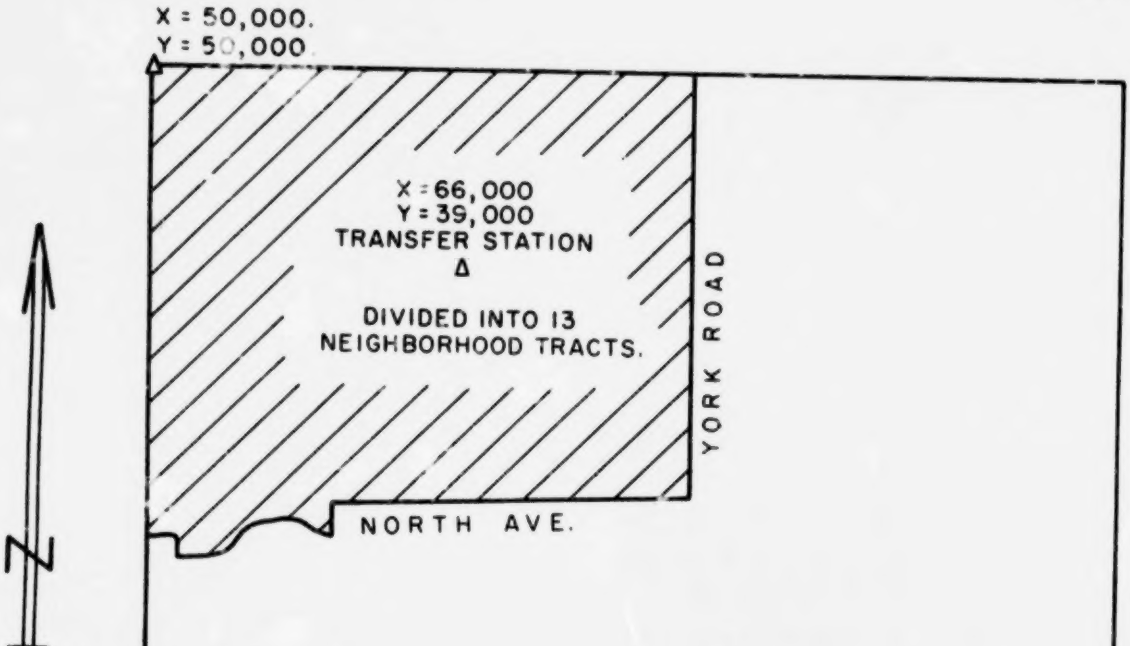

X = 50,000.
Y = 50,000.
X = 66,000
Y = 39,000
TRANSFER STATION
Δ
DIVIDED INTO 13
NEIGHBORHOOD TRACTS.
YORK ROAD
NORTH AVE.
N

FIGURE 6 - 1

Northwest Baltimore

Served with One Transfer Station

TABLE 6-1. SUBAREA DATA FROM NORTHWEST QUADRANT OF BALTIMORE

				METRIC L				
				Population Center				
Area Number	Neighborhood Type	Designation of 1960 Census Tracts	Number of Household Units	AX1	AY1	AX2	AY2	ROADIS
1	1	28-1B 28-2 28-3	2,482 2,035 1,194 5,711	53,100	34,600	66,000	39,000	--
2	2	28-1A	1,099	54,200	41,800	54,200	41,800	11,900
3	1	27-19 27-20	1,490 4,634 6,124	56,400	45,600	56,400	45,600	12,400
4	2	27-17	2,079	62,300	42,200	66,000	39,000	

TABLE 6-1. SUBAREA DATA FROM NORTHWEST QUADRANT OF BALTIMORE (cont.)

Area Number	Neighborhood Type	Designation of 1960 Census Tracts	Number of Household Units	METRIC L				
				Population Center				
				AX1	AY1	AX2	AY2	ROADIS
5	3	15-17	2,011	63,200	38,500	63,200	38,500	2,600
		15-13	1,910					
		27-16	1,979					
		27-17	2,079					
		27-18	3,207					
			11,186					
6	2	15-7A	865	59,500	32,900	66,000	39,000	
		15-8A	1,787					
		15-8B	493					
		15-9	1,574					
		15-10	2,249					
		15-11	2,691					
			9,659					
7	1	27-11	780	29,300	42,900	29,300	42,900	8,300
		27-12	2,159					
		27-13	913					
		27-14	1,543					
		27-15	1,904					
			7,299					

TABLE 6-1. SUBAREA DATA FROM NORTHWEST QUADRANT OF BALTIMORE (cont.)

Area Number	Neighborhood Type	Designation of 1960 Census Tracts	Number of Household Units	METRIC L Population Center AX1	AY1	AX2	AY2	ROADIS
8	2	12-1	1,887	82,600	38,700	82,600	38,700	12,500
9	3	13-5	523	81,500	35,500	81,500	35,500	8,900
		13-6	1,426					
		13-7	1,918					
		13-8	2,039					
			5,906					
10	4	12-2	3,839	83,000	31,100	83,000	31,100	16,100
		12-3	1,987					
		12-4	1,687					
		12-6	1,532					
		12-7	1,474					
			10,519					

TABLE 6-1. SUBAREA DATA FROM NORTHWEST QUADRANT OF BALTIMORE (cont.)

				METRIC L				
				Population Center				
Area Number	Neighborhood Type	Designation of 1960 Census Tracts	Number of Household Units	AX1	AY1	AX2	AY2	ROADIS
11	4	13-1	1,917	71,600	28,600	66,400	30,600	10,200
		13-2	2,062					
		13-3	1,598					
		13-4	1,154					
			6,731					
12	3	15-4	1,576	66,600	28,300	66,600	28,300	13,100
		15-5	741					
			2,317					
13	3	15-7B	1,787	62,100	28,000	66,400	30,600	10,200
		15-6	2,150					
			3,937					

TABLE 6-2

MODEL 3 RUNS

Run No.	Model No.	Collection frequency	Haul distance	Over-time paid	Com-paction apparatus	NOTRC value	Transfer station
1	3C	2/week	24	yes	no	0	Y
2	3A	2/week	24	yes	no	-	N
3	3C	3/week	24	yes	no	0	Y
4	3A	3/week	24	yes	no	-	N
5	3C	2/week	8	yes	no	0	Y
6	3A	2/week	8	yes	no	-	N
7A	3C	3/week	8	yes	no	0	Y
7B	3C	3/week	8	yes	no	0	Y
7C	3C	3/week	8	yes	no	0	Y
7D	3C	3/week	8	yes	no	0	Y
7E	3C	3/week	8	yes	no	0	Y
8	3A	3/week	8	yes	no	-	N
9	3C	2/week	16	yes	no	0	Y
10	3A	2/week	16	yes	no	-	N
11	3C	3/week	16	yes	no	0	Y
12	3A	3/week	16	yes	no	-	N
13	3C	2/week	4	yes	no	0	Y
14	3A	2/week	4	yes	no	-	N
15	3C	3/week	4	yes	no	0	Y
16	3A	3/week	4	yes	no	-	N
17	3A	2/week	9	no	no	-	N
18	3A	2/week	9	no	no	-	N
19	3A	3/week	9	no	no	-	N
20	3A	3/week	9	no	no	-	N
21	3C	2/week	4	yes	yes	2	Y
22	3C	2/week	16	yes	yes	2	Y
23	3C	2/week	24	yes	yes	3	Y

TABLE 6-2

MODEL 3 RUNS (cont.)

Run No.	Model No.	Collection frequency	Haul distance	Overtime paid	Compaction apparatus	NOTRC value	Transfer station
24	3B	2/week	8	yes	no	0	Y
25	3B	3/week	8	yes	no	0	Y
26	3C	2/week	12	yes	no	0	Y
27	3C	2/week	12	yes	no	0	Y
28	3C	3/week	8	yes	no	2	Y
29	3C	3/week	8	yes	no	4	Y
31	3C	2/week	12	yes	no	0	Y
32	3C	2/week	12	yes	no	0	Y
33	3C	2/week	12	yes	no	0	Y

Runs 1 through 16 gave general comparison of semiweekly and triweekly collections with and without transfer stations.

Runs 7A, B, C, D, and E tested sensitivity of responses to different random number sequences.

Runs 17 and 18 were made to prove the model.

Runs 19 and 20 simulated triweekly collection in the Baltimore area under investigation.

Runs 21, 22, 23 tested auxiliary compaction apparatus.

Runs 24 and 25 tested no queueing condition.

Runs 26 and 27 gave responses to two transfer stations in the area.

Runs 28 and 29 varied the tractor-trailer ratios at a transfer station.

Runs 31, 32, and 33 gave responses to three transfer stations in the area.

1. PROVING THE MODEL

Two runs were made duplicating present Baltimore city system. The model responses were compared with system values to evaluate the model. The results are:

	Dollars per ton	Tons per day	Trucks needed
Model Run 1	10.67	295	29
Model Run 2	10.70	297	29
System	10.49	291	24-30

2. MODEL RESPONSES TO INTERACTIONS OF VARYING COLLECTION FREQUENCIES AND HAUL DISTANCES WITH AND WITHOUT A TRANS-STATION

and

3. DETERMINATION OF CRITICAL DISTANCES BEYOND WHICH THE USE OF A TRANSFER STATION IS ECONOMICALLY FEASIBLE

Sixteen runs were made for the above two objectives. Figure 6-2 incorporates the results. Model policies for these runs paid overtime and assigned a sufficient number of tractors that overtime averaged no more than four hours per week per driver. The results were:

Run	Transfer station	Collection frequency	Haul distance	Total cost/ton
1	yes	2/week	24	$ 11.08
2	no	2/week	24	14.41
3	yes	3/week	24	11.97
4	no	3/week	24	15.08
5	yes	2/week	8	10.57
6	no	2/week	8	10.57
7	yes	3/week	8	11.38
8	no	3/week	8	11.56
9	yes	2/week	16	10.65
10	no	2/week	16	12.53
11	yes	3/week	16	11.49
12	no	3/week	16	13.32
13	yes	2/week	4	10.30
14	no	2/week	4	9.48
15	yes	3/week	4	11.15
16	no	3/week	4	10.31

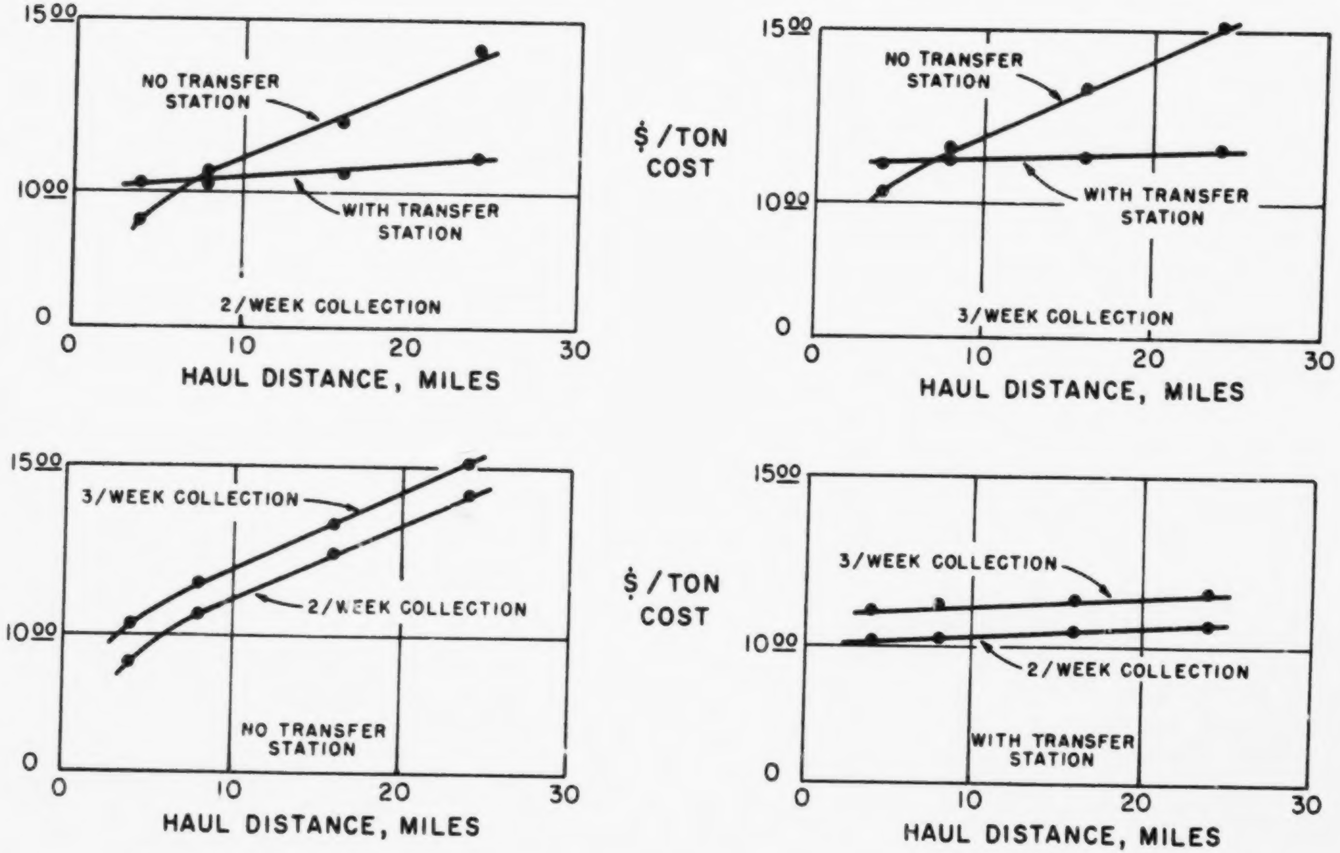


FIGURE 6 - 2

Costs vs. Haul Distance

4. MODEL RESPONSES TO INCREASING COLLECTION FREQUENCY TO TRIWEEKLY

Two runs were made identical to those proving the model except with triweekly collection rather than semiweekly. Haul was made by the collection trucks to the incinerators as in the system. Comparison with the semiweekly runs is made below:

Run Number	Collection frequency	Max tons per day	Cost $/ton	Number trucks	Length of work day	
					Average	Stnd.dev.
17	2/week	295	10.67	29	6.8	1.5
18	2/week	297	10.70	29	6.6	1.3
19	3/week	338	11.62	36	6.4	1.5
20	3/week	341	11.65	36	6.4	1.6

5. EFFECT OF AUXILIARY COMPACTING EQUIPMENT AT TRANSFER STATION

Throughout most of this study, the assumption was made that the solid waste within the trailers was at a density between 400 and 450 pounds per cubic yard. Auxiliary compacting equipment can be installed at the transfer station which increases the pay load, having increased the solid waste density in the haul trailers to the order of 800 pounds per cubic yard. Three runs were made with the capital investment of the transfer station having been increased by the cost of buying and installing this equipment, approximately $150,000, and the trailer net weight limit having been increased from 30,000 pounds to 60,000 pounds. Otherwise the new runs were identical in policies with their counterparts without the compacting equipment. A comparison of responses of semiweekly collections with and without this apparatus is given below:

Run number	Compacting equipment	Haul distance	Number of tractors and trailers	$/ton transfer station	$/ton collection only	$/ton total
21	yes	4	2 & 3	1.27	9.04	10.31
13	no	4	2 & 3	1.23	9.06	10.29
22	yes	16	2 & 5	1.42	8.97	10.39
9	no	16	3 & 7	1.64	9.01	10.65
23	yes	24	3 & 5	1.60	9.09	10.69
1	no	24	4 & 6	2.00	9.08	11.08

6. SENSITIVITY OF COSTS TO NUMBER OF TRANSFER STATION UNLOADING DOCKS, A COMPARISON OF RESPONSES FROM MODELS 3B AND 3C

Model 3B operates with unlimited unloading space for the collection trucks, which results in no lost time in queues. Two runs, numbered 24 and 25, were made using Model 3B. Other conditions were identical with runs numbered 5 and 7, which were made using Model 3C, i.e., two unloading docks and queueing. The results of these runs are shown below:

Run	Collection frequency	Model	% time at disposal	Ave. time at disposal (minutes)	Total cost $/ton	Ave. length work day (hours)
5	2/week	3C	4.8	7.4	10.57	6.7
24	2/week	3B	3.8	5.8	10.57	6.6
7	3/week	3C	4.1	7.6	11.38	6.2
25	3/week	3B	3.3	6.1	11.34	6.2

7. SENSITIVITY OF RESPONSES TO NUMBER OF TRANSFER STATIONS IN THE AREA

Runs 1 through 16 investigated model responses with and without a transfer station for different combinations of collection frequencies and haul distances. The urban area was further divided so as to be served by two transfer stations, runs 26 and 27; and to be served by three transfer stations, runs 31, 32 and 33. The results for a 12 mile haul distance are shown below.

Figure 6-1 is a sketch of the area and the transfer station location when it was served by a single station. Figure 6-3 is a sketch of the division of the urban area and the two transfer station locations when served by two stations. Figure 6-4 shows the same when served by three stations.

No. of transfer stations	Total no. of trucks	No. of tractors and trailers	Cost of transfer stations (dollars)	Cost $/ton
None	31	-	-	12.10
One	24	3 & 7	278,000	10.61
Two	23	4 & 9	370,000	10.75
Three	24	6 & 9	495,000	11.42

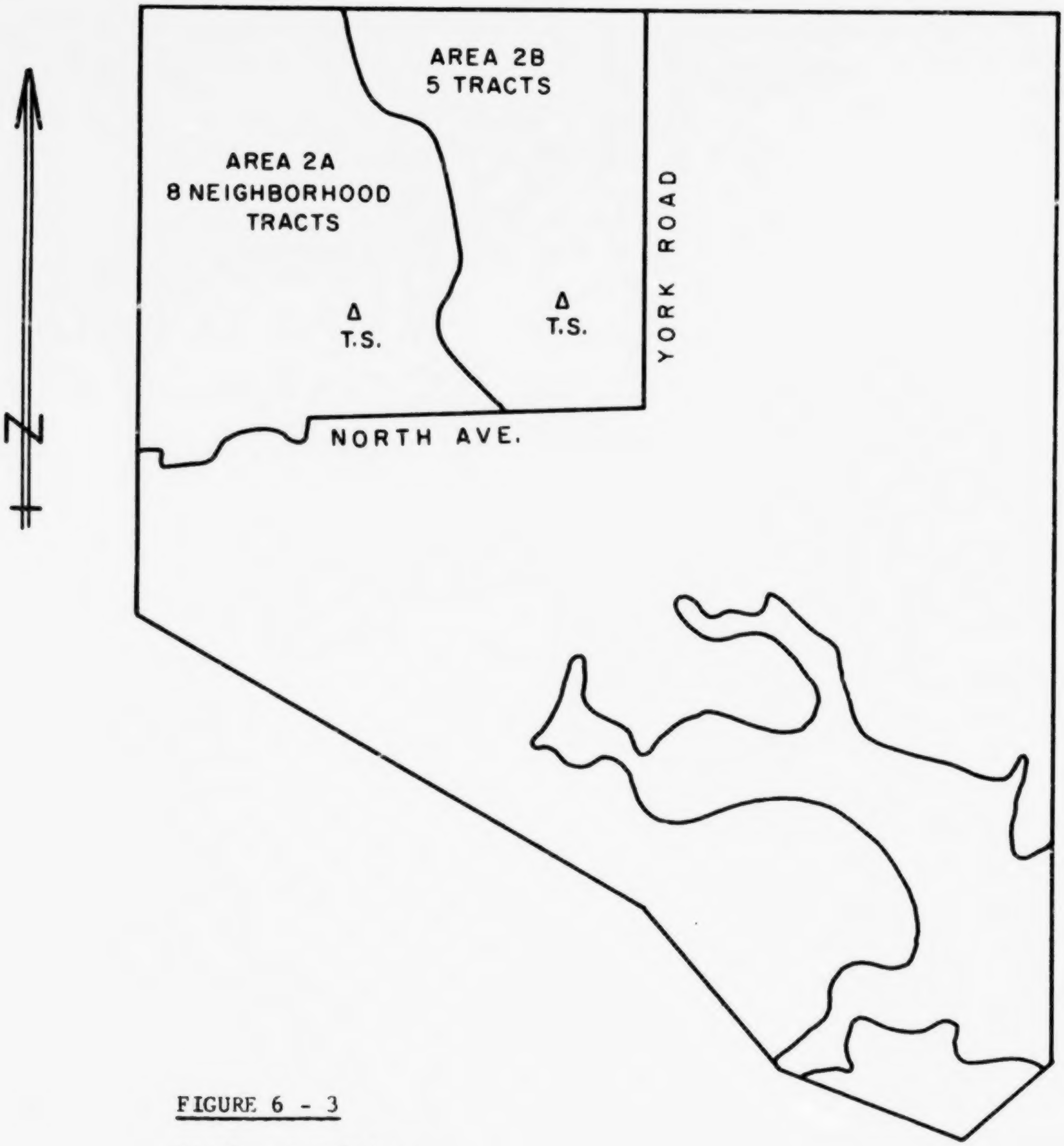

AREA 2B
5 TRACTS
AREA 2A
8 NEIGHBORHOOD
TRACTS
Δ
T.S.
Δ
T.S.
YORK ROAD
NORTH AVE.
N

FIGURE 6 - 3

Northwest Baltimore

Served with Two Transfer Stations

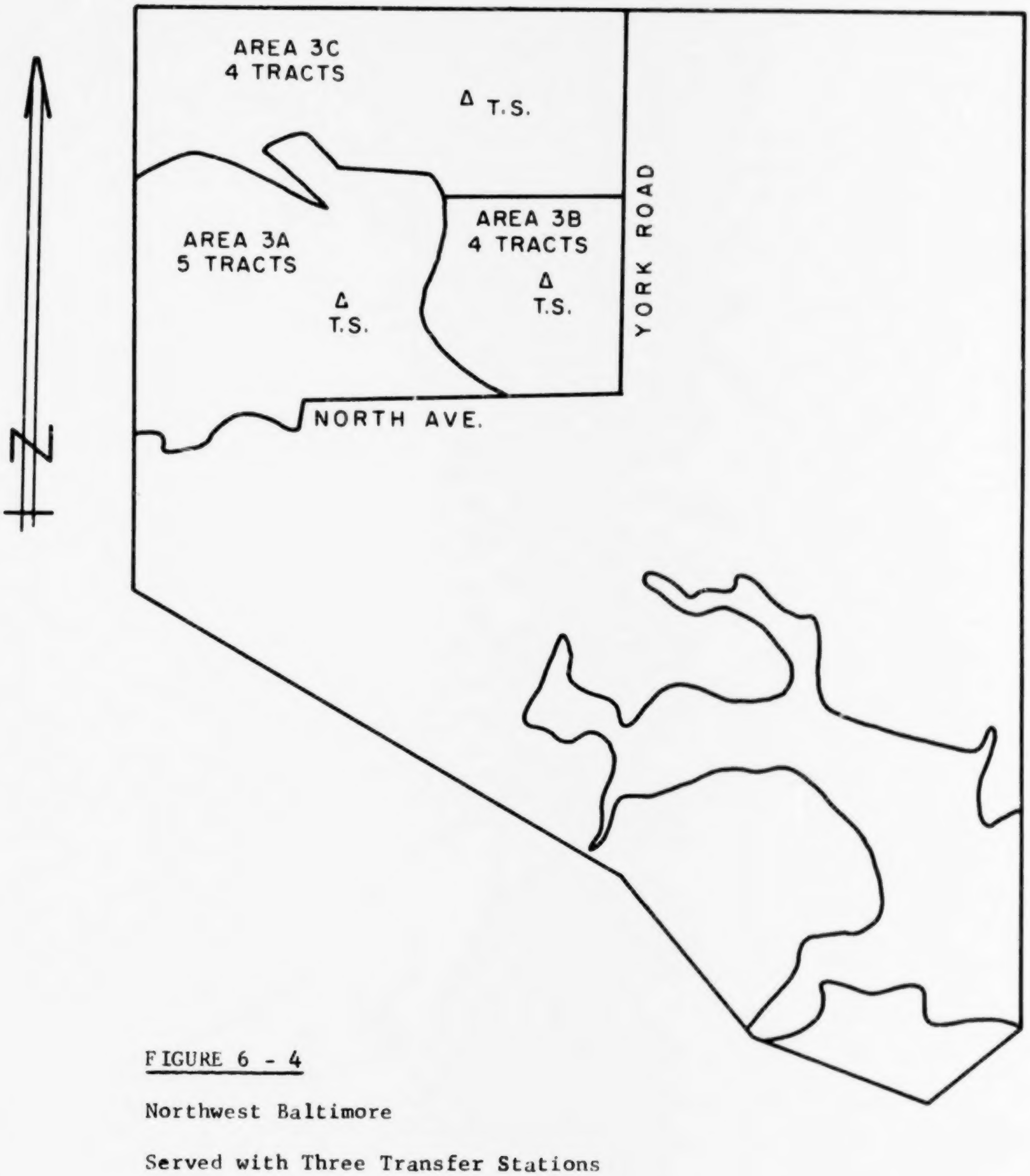

AREA 3C
4 TRACTS
Δ T.S.
AREA 3A
5 TRACTS
Δ T.S.
AREA 3B
4 TRACTS
Δ T.S.
YORK ROAD
NORTH AVE.
N

FIGURE 6 - 4

Northwest Baltimore

Served with Three Transfer Stations

8. SENSITIVITY OF RESPONSES TO DIFFERENT TRACTOR-TRAILER RATIOS AT THE TRANSFER STATION

An empirical equation is used in Model 3 which determines the number of tractors to be assigned to a transfer station; this has been discussed in Chapter 6. The use of the equation is optional with the user. Two runs, numbered 28 and 29, were made with the number of tractors being one more and one less than that given by the equation. Otherwise identical conditions exist as in run 7, the run in which the model's equation calculated the number of tractors. The results are:

Run	Value of control variable NOTRC	No. of tractors	No. of trailers required	Transfer station cost/ton	Ave. no. of overtime hours per tractor
28	2	2	10	1.53	11*
7	0	3	7	1.57	3
29	4	4	6	1.64	2

*violates arbitrary constraint of maximum of four overtime hours per week

9. SENSITIVITY OF MODEL RESPONSES TO DIFFERENT RANDOM NUMBER SEQUENCES

Five runs were made under identical conditions except for random number generation. The control variable, K, was set equal to zero for all runs. The model simulated triweekly collection with a transfer station, overtime being paid, haul distance equal to eight miles, queueing occurring, and no auxiliary compacting equipment at the transfer station. The model responses included:

Run	No. of trucks	Tonnage	$/ton collection	$/ton T.S.	$/ton total	No. of tractors and trailers	Hours of overtime for trucks
7A	30	1537	9.81	1.57	11.38	3 & 7	32
7B	30	1533	9.76	1.57	11.32	3 & 7	35
7C	30	1539	9.84	1.56	11.40	3 & 7	36
7D	30	1531	9.81	1.55	11.36	3 & 8	34
7E	30	1546	9.72	1.56	11.28	3 & 8	24

CHAPTER 7. CONCLUSIONS AND SUMMARY

Introduction

Three models were prepared in this study, the first two being somewhat general in some of the assumptions upon which they are based, the last one having the potential to operate realistically under most policies and environmental variables of a real refuse collection system in an urban residential area.

The general objective of this study was the preparation of such a model and has been completed.

One of two specific objectives was securing order of magnitude of relative costs of increasing collection frequency from semiweekly to triweekly. This has been investigated for general conditions with Models 1 and 2; furthermore it has been investigated for a specific urban area with Model 3. Cost increases were found to be from 10% to 25%. The second specific objective was the delineation of system properties under which the use of a transfer station is economically feasible. This has been done for an existing large urban tract with Model 3, and again, other existing urban areas could be similarly investigated with the Model. The feasibility of the use of a transfer station is presented as a function of collection frequency and haul distance between transfer station and final disposal site for this urban mixed neighborhood tract.

The first specific objective, comparison of semiweekly collection costs versus triweekly collection costs, is summarized in Figures 4-8 and 6-2, and in Section 4 of Chapter 6. The second specific objective, presentation of variable combinations for which a transfer station is economically feasible in a collection system, is shown in Figure 6-2.

In addition to the above, other model results were obtained which are indicative of probable systems responses to changes in policies and equipment. Chapter 7 is now divided into separate discussions of the following topics:

1. Limitations of Present Study and Areas for Further Investigation
2. Results from Model 3 Runs
3. Results from Models 1 and 2 Runs
4. Triweekly and Semiweekly Collection Systems

1. LIMITATIONS OF PRESENT STUDY AND AREAS FOR FURTHER INVESTIGATION

All models are structured so that performance data from another city can be substituted for those used in this study. It is uncertain to what extent the histograms and regressions used are representative of all urban areas in the United States. A comparison of this performance information with similar information from other large cities would be valuable. Severe winter effects are not reflected in this study. Observations of weights of solid waste produced and collection rates for triweekly collection would be valuable replacements for the assumed values.

The large difference in the models' responses between neighborhood type 1 conditions and the more dense areas suggests that neighborhood type 1 is too large a classification. More meaningful results would perhaps appear if it were less inclusive.

The data included weights collected, distances covered, elapsed times, breakdown frequencies, and noted equipment types, costs, etc.; it did not make population counts. Correlation between collected weights and the number of people generating these weights was made from five years of records for the entire city, but information was not available for weights and population generating them for smaller areas. Model 3 would be improved if field data were gathered and processed so that the distributions of refuse weights per capita per day by neighborhood types were available for statistical testing for indications of significant difference. If the distributions were found to be significantly different, the models' single normal distribution of weight per person per day would be replaced by the applicable sets for the four neighborhood types.

The location of the transfer station is fixed for the entire simulated week of the operation. The location may be changed for subsequent runs, of course. It appears that if a large area being served by triweekly collection were divided into two subareas, with all collection trucks working in one subarea on one of the week's routes, and in the other on the other route, then economy could be realized if a mobile transfer station could serve both areas on separate sites. The equipment would have to be of such a nature that the daily moving from one subarea to the other could be done easily and economically. This is similar to the situation of having two transfer stations in the large area except the mobile concept presupposes only one transfer station crew and only one investment in equipment. It is thought that a completely new model would be needed to investigate this system, although parts of Model 3 perhaps could be used.

2. RESULTS FROM MODEL 3 RUNS

2A. Proving the Model

Many runs were made with the final model, Model 3; all had an existing tract, the northwest quadrant of Baltimore or a portion of the quadrant, as a working area. Most of the runs were made for the investigation of operating policies which in time might be considered for the system. However, two runs were made with policies and conditions as close as could be obtained to the existing system, i.e., no transfer station, Baltimore pay scales and truck operating charges, no overtime pay, semiweekly collection frequency, etc. Lack of similarity between model and system included: (1) effect of adverse weather conditions on operation; (2) the system fields a few small trucks in the area in addition to the large trucks which are the usual type in use; the model fielded only large trucks. The complete numerical results of the model runs which can be compared with the system are in Chapter 6. The model gave unit cost about 2% above the City's figure. Also the model indicated approximately 2% more weight collected than the City indicated. The model fielded 29 trucks daily to service the area; the City indicated from 24 to 30 trucks in regular use. These small discrepancies seemed to indicate a reasonably accurate model, the differences being easily attributable to random number sequences and variations in the real system.

2B. Disposal Site and Transfer Station Site Planning

The costs of different proposed locations of disposal sites or transfer stations can be estimated by making individual runs with each of the locations incorporated in Model 3. The value of such comparisons may not necessarily be merely the determination of which of several alternatives is the most economical, but rather the securing of an estimate of the extra cost resulting from the acceptance of a site which is not the most economical, but which must be used because of other reasons, political, altruistic, etc.

2C. Critical Haul Distance for Transfer Station Feasibility

Figure 6-2 indicates costs for servicing the subject area with and without a transfer station for triweekly and semiweekly collection frequencies. The values are applicable only for the model's Baltimore data, but similar curves, certainly with different values, can be obtained for other tracts with other characteristics. The curves show a critical haul distance of approximately eight miles above which a transfer station would be a good addition to the system in northwest Baltimore. It is noted that critical distance is affected very little by collection frequency; it is approximately the same both for semiweekly and triweekly collection frequency. A discussion of this follows:

The two lower drawings of Figure 6-2 illustrate that the two curves with transfer station are parallel; the two curves without transfer station are parallel also. In each case, the additional cost of increased frequency is due to extra time in the collection activity and is not a function of the traffic haul distance. The additional cost, the ordinate increment, is very nearly the same between the two parallel sets. When the curves are overlain, the geometry of the resulting figure will be such that the critical distance for a triweekly system will be the same as for the semiweekly.

If a transfer station is installed because of indicated efficiency while collection is semiweekly, it will be equally desirable if frequency is increased to triweekly.

2D. Equipment Planning

Equipment decisions as to probable number of tractors and trailers, trailer capacity, and the use or non-use of auxiliary compaction apparatus at the transfer station may be indicated by model response. This study's runs indicated that the extra investment in the compaction apparatus is justified whatever the haul distance to the final disposal site. If the haul distance between transfer station and disposal area were 24 miles, the annual savings due to this auxiliary compaction apparatus would be of the order of $31,000.00. This figure does not give consideration to maintenance costs, if any, and possibilities of inconveniences of equipment breakdown.

However, for different traffic speed relations, different transfer station capacities, different labor pay scales and tractor hourly charges, there perhaps would be no similar justification for all haul distances, but rather the responses would indicate a critical haul distance below which the equipment investment would not be justified.

2E. Comparison of Complex Systems

A number of runs were made to determine the relative costs of several disposal sites at different distances from the subject area. This may be expanded for a situation in which a large urban tract has the choice of M disposal sites and N transfer station sites. MN model runs will give responses for the combinations of each disposal site with each transfer station site.
M more runs will give the same information for the simulated system operating without transfer station with delivery by the collection trucks directly

to each of the disposal sites. More runs can investigate the possibilities of the most economical arrangement being the joint use of more than one of the transfer sites, each having a reduced capacity, combined with a single disposal site. This latter thought was illustrated in this study when the subject area was served by none, one, two, and three transfer stations all with a final haul of twelve miles. This series of model runs indicated that the minimum cost was realized with only one large station. As always, the minimum cost situation can not be generalized as it depends on the system being simulated.

With such usage for initial indications of costs and other system responses, further investigation can be made to determine desirability of different overtime pay policies, compacting apparatus, and type and capacities of rolling stock.

2F. Effect of Queueing

Model 3B operated with conditions of an unlimited number of unloading docks while Model 3C had only two docks resulting in queueing at times. The model policy placed an incoming collection truck in the shorter of the queues if two queues existed and at dock number one if no queues were present or if queue lengths were equal. System responses with and without queueing both for semiweekly and triweekly collection frequencies were noted. The semiweekly cost for transfer station operation, which includes the tractor trailer operations, increased $0.01 per ton with queueing; the triweekly cost increased $0.02 per ton with queueing.

The average percent of time at disposal site for the collection trucks, increased from average values of 3.5% to 4.5% with queues. Delays due to queueing for the system being simulated cost of the order of magnitude of 0.1% of the total system cost. The system responses are not sensitive to the increase in unloading space, and thus it can be concluded that additional unloading docks are not justified.

2G. Number of Trucks and their Assignment to Areas

Tables 1 and 2 of the Model 3 print-out may be planning aids by themselves without the remaining model responses being of particular interest. Table 1 divides each subarea into daily truck routes of equal number of household units compatible with the neighborhood type of the subarea, the distance between the subarea and the collection trucks' dumping site, and the collection frequency. Table 2, using the information from Table 1, assigns trucks which are numbered 1, 2, 3, etc., to particular subarea routes by days of the week. In this manner, an indication of the necessary number of collection trucks and their assignments for a proposed system is given to the investigator. The control variable, ASSUNK, is in the model for this planning use. If the assignments for the trucks appear too large due perhaps to some local constraint, reducing the value of this variable from its normal value of 1.0 to 0.9 or 0.8 will reduce the average assignment somewhat accordingly, and vice versa.

Model results are improved if each subarea is sufficiently large that at least three or four daily routes are within it.

The assignment logic programmed in the model places trucks about equally over the entire area each day of the week rather than concentrating them in different parts of the area on different days. This policy has two virtues: (1) Trucks are not concentrated in a neighborhood on some particular days of the week; and (2) The load of the incinerator or transfer station is equalized between days of the week. To explain further, if on Mondays and Thursdays all trucks are working with a long haul distance, and if on Tuesdays and Fridays, all trucks are working with a short haul distance, the Monday-Thursday assignment of household units will be appreciably smaller than the Tuesday-Friday assignment. Different daily collection weights will result from this. Further compounding of the weight differential already resulting from different number of days since last collection is not needed. This logic is not followed by all contemporary urban systems.

3. RESULTS FROM MODELS 1 AND 2

The results from these two models served as basis for Model 3; this is probably their greatest value. However, one of the specific purposes of this study was the investigation of relative costs of triweekly versus semiweekly collection, and results from these models gave insight into this relation.

Figures 4-3 and 4-4 present number of households and gross acres covered as functions of the affecting variables. This gross acreage is based on the average ratios between net and gross acreages in the city of Baltimore and certainly will vary with different cities. The plots showing the number of household units serviced as functions of these variables are of more general application. It is believed that these may serve a practical use in design as a starting point in task assignment planning.

The significances indicated by the statistical testing for "haul distance" and "days since last collection" were anticipated. The significance of the neighborhood type was also anticipated, but not to the degree attained.

No significant differences in traffic velocities were indicated by the statistical testing between the large and small trucks or between empty and full conditions. These results are contrary to beliefs held by some supervisory personnel who are operating existing systems.

Runs with Model 2 indicated that the greater the assignment, the less cost per ton of the simulated system. Two reasons exist for this. Firstly, the crews receive a full day's pay regardless of the early hour at which their work may be done during the latter part of the week. The increased assignments eliminated these nonproductive manhours for which pay was received. Secondly, Model 2 is programmed so that considerable off route time is built into the regular work day, making the regular work hour have only 45 to 50 minutes of productive time. The model, however, treats an hour of overtime as fully productive except for truck breakdowns. It is believed this parallels the system as long as overtime does not become excessive. The model's responses to increased assignments suggest that policy which causes overtime on the early days of the week and a full day's work for the latter days of the week is efficient if acceptable to the representatives of labor.

4. SEMIWEEKLY AND TRIWEEKLY COLLECTION SYSTEMS

Semiweekly versus triweekly collection frequencies when simulated by Model 2 indicate that little additional travel in traffic is required and that the major additional expense when increasing collection frequency is the additional mileage and time in the collection neighborhood. The simulated triweekly collections, although more costly than semiweekly, averaged shorter workdays. The reason for this is developed in the following discussion.

The difference in workday length between a first pass on a route and subsequent collections in the week on the same route is greater for the triweekly frequency than for the semiweekly frequency. This compounds the problem of task assignments; if they are made with the aim of a full work day for the later workdays, the first of the week will be heavily overtime. This study's models operate under the former policy of averaging a full day's work the first part of the week and finishing early the latter part, as it was believed this more closely duplicates most urban systems. A semiweekly policy generates three full days and three short days; a triweekly policy generates two full days and four short days.

The model's results emphasized that a city making the decision between triweekly and semiweekly collection must consider the relative weights on the design capacity of the disposal points. Assuming that per capita generation of waste does not vary with days of the week and assuming equal number of households to be collected each day of the week, the following table shows the percentage of week's total weight for each day:

Percentage of Week's Weight

Collection frequency	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Fortnightly	16.7	16.7	16.7	16.7	16.7	16.7
Weekly	16.7	16.7	16.7	16.7	16.7	16.7
Semiweekly	19.0	19.0	19.0	14.3	14.3	14.3
Triweekly	21.4	21.4	14.3	14.3	14.3	14.3
Daily	28.6	14.3	14.3	14.3	14.3	14.3

Less variance between daily total collections exists with semiweekly than with triweekly policy. Theoretically this requires a larger transfer station for triweekly than for semiweekly collection frequency. Figure 7-1 shows the above for theoretical percentages, which assume no extra

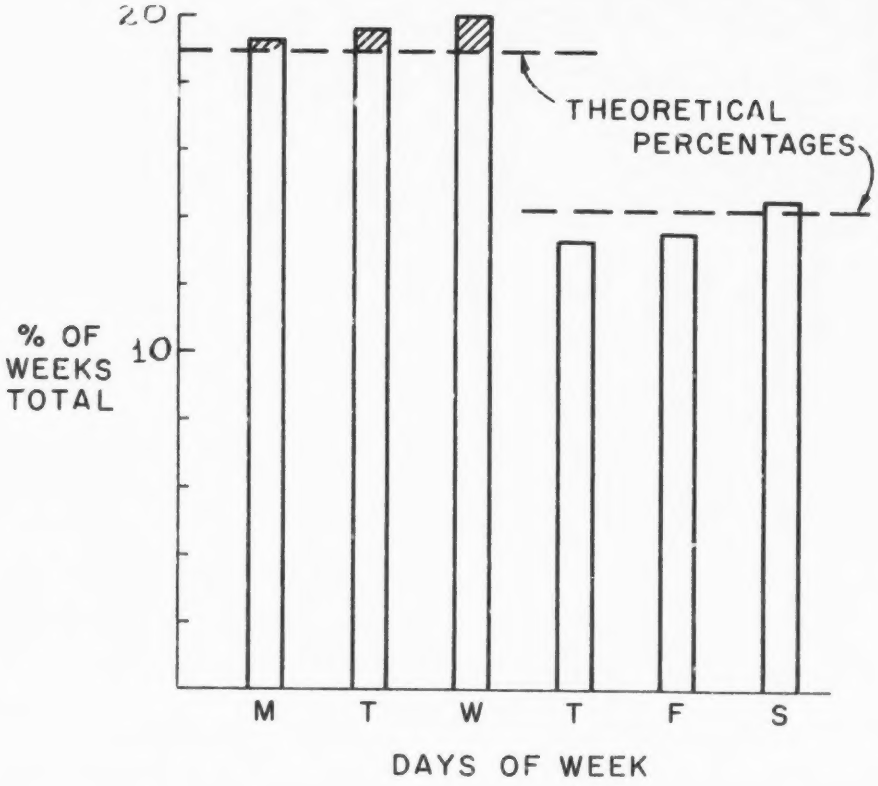


FIGURE 7 - 1

Waste Generation by Days of the Week, Baltimore System weekend waste generation, plotted against observed residential collection weights.

In addition to a reasonable safety factor in the design, this plotting suggests that transfer station or incinerator capacity should be based on higher capacity than that indicated by the theoretical daily percentages. This increase is due to extra week-end waste generation (cross-hatched area in Figure 7-1), imbalance in route assignments (difference in Figure 7-1 ordinates for M, T, and W), or a combination of the two.

If a transfer station is being considered, the decisions previously discussed concerning workday lengths for collection trucks now become pertinent for the station operation. If a triweekly frequency is system policy, the number of laborers for transfer station operation on Mondays and Tuesdays perhaps will be excessive for the remainder of the week. If a sufficient number of tractors and trailers are present for Monday and Tuesday, drivers and tractors will be idle a part of the time for the remaining four days.

Model 3 of this study has policies believed acceptable and probable in an actual system. The transfer station staff of laborers was sufficient to handle the heavy days and was constant through the week.

The model makes no provision for overtime payment for transfer station laborers as staggered shifts should eliminate the need for overtime for these men. A driver was assigned to every tractor; overtime was planned for tractors and drivers on the heavy early days of the week, but an overtime constraint was imposed of no more than an average of four overtime hours per week per driver. Actually it averaged appreciably less on the model's runs.

The model responses to triweekly and semiweekly collection frequencies in Northwest Baltimore is seen best in Figure 6-2. The increase in cost due to increased collection frequency remains nearly constant regardless of collection truck haul distance or the presence or absence of a transfer station. The indicated increase is of the order of $0.85 per ton, less than a 10% increase for the different conditions of the runs. The difficult period of change in the system, the new route assignments and familiarizations, and the necessary planning of shifts for personnel probably prevent change from semiweekly to triweekly policy as much as the increase in costs.

APPENDIX A

DATA FROM THE CITY OF BALTIMORE

The Bureau of Sanitation of the City of Baltimore operates residential solid waste collection services daily except Sunday. Collections are made twice a week from each residential unit within the city, either on Monday and Thursday, or on Tuesday and Friday, or on Wednesday and Saturday. The compacter trucks have a crew of a driver and three laborers on Monday, Tuesday, and Wednesday; they have a driver and only two laborers on Thursday, Friday, and Saturday. This arrangement is because the first of the week collections contain four days' accumulation, while the later collections contain only three days' accumulation. The city has two sizes of trucks although many different manufacturers are represented; these sizes are 13 cubic yard and 20 yard capacities. The smaller truck is designated locally as a three ton truck, and the larger is designated as a five ton truck. The smaller size is considered less economical than the larger and so is used only in narrow alley operations.

Intensive data collection was carried out throughout Baltimore City in the late winter of 1966-67. For a two week period every compacter truck operating within the City maintained a log on the second complete trip of each day. Baltimore normally has about 95 compacter trucks operating daily. The two week period (twelve days) had a potential of 1140 reports; approximately 4/5 were received in usable condition. Those not received were due chiefly to trucks without speedometers and to a lesser degree to driver illiteracy. The dumping times at the City's two incinerators were observed and recorded by the author.

Discussions were held both with Regional Planning Council personnel and with personnel from the City Planning Board of the City of Baltimore before reaching a decision as to a simple manner of classifying urban residential areas. The only considerations of interest were those which affected the amount of solid waste generated per acre or the speed with which the collection was carried out. The neighborhood classification finally adopted was based on the number of housing units per acre of net residential land. The term "net residential land" excludes public streets and alleys and refers to the acreage in residential use only. The term "housing unit" is defined [City of Baltimore, 1964] as, "a house, apartment, or other group of rooms, or a single room occupied or intended for occupancy as separate living quarters - i.e., the occupants do not live and eat with any other persons in the structure, and there is either (1) direct access from the outside or through a common hall, or (2) cooking equipment for the exclusive use of the occupants."

The study's classification of neighborhood types is:

Classification	Housing Units per Net Acre
1	Ten or less
2	11 to 20
3	21 to 40
4	More than 40

The distributions of the number of housing units per net acre are not generally uniform within the various neighborhood types in Baltimore. Figures A-1, A-2, A-3, and A-4 show the actual distributions. These histograms were drawn from in a random manner to determine the household density from which collection was made by each truck in each model.

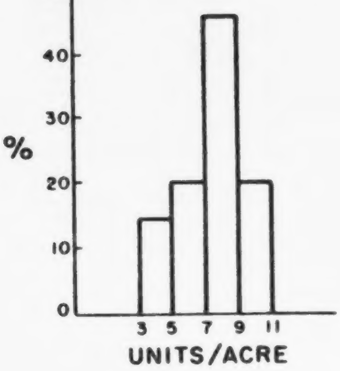


FIGURE A-1
NETYP = 1

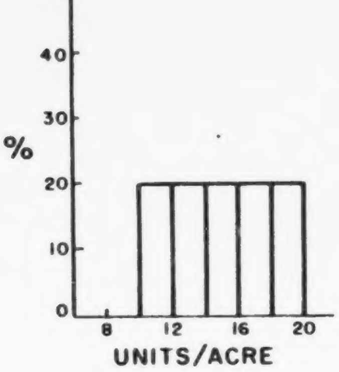


FIGURE A-2
NETYP = 2

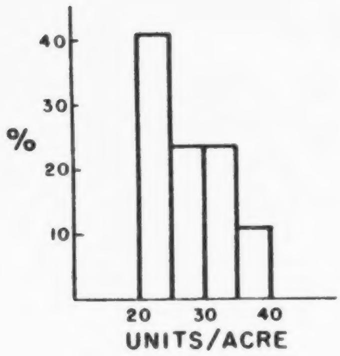


FIGURE A-3
NETYP = 3

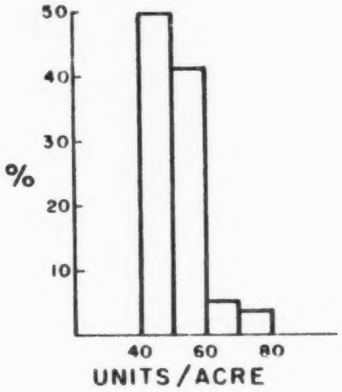


FIGURE A-4
NETYP = 4

Distributions of Housing Units per Net Acre
by Neighborhood Type

Weight Generated and Hauled

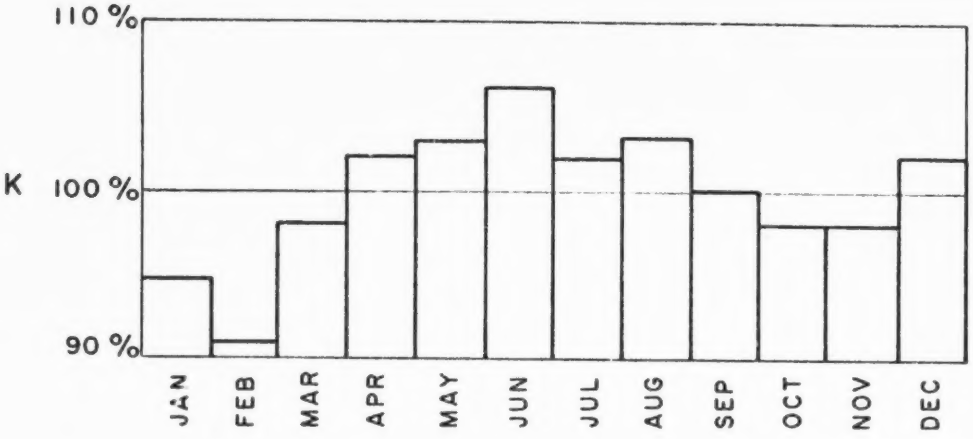
The daily weight of solid waste generated within Baltimore varies seasonally, winter weights being as much as 8 per cent below the yearly average and summer weights being well above the yearly average. Table A-1 and Figure A-5 give values and graphical representation of this variation for the five year period including 1962 until 1966. The difference in weights of solid waste to be collected from the same area on Mondays as compared to Thursdays has been mentioned earlier. Figure A-6 shows values for a three-week period in January, 1967. A seasonal shift in the weight of solid waste generated was noted; it is due largely to yard clippings and summer pruning and to a smaller degree to fresh fruit and vegetable trimmings.

In Baltimore, drivers make the decisions as to when trucks have been filled sufficiently to return to the incinerator for unloading. The field data showed a very large variation in the weights and degrees of compaction attained in returning trucks. It is noted again here that none of these "full" loads were the last of the day. Figure A-7 shows the distribution of "full" weights for 68 loads of 13 cubic yard capacity trucks. Figure A-8 shows the distribution of "full" weights for 227 loads of 20 cubic

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1962	28.3	23.7	28.4	27.6	30.7	29.3	29.6	30.5	27.1	29.9	28.0	28.7	342.4
1963	27.8	24.2	29.1	31.0	31.5	30.1	31.4	30.8	28.6	30.4	27.8	31.6	354.8
1964	29.8	26.8	29.2	30.5	31.1	31.7	32.0	30.6	29.9	30.2	29.3	34.1	365.6
1965	29.0	25.5	30.2	30.3	31.2	32.9	32.6	33.3	31.5	27.4	27.5	28.8	360.7
1966	24.2	23.8	28.2	27.2	30.3	30.0	27.7	30.0	28.2	27.7	27.6	28.4	333.9

TABLE A-I

Solid Waste in 1,000 Tons Generated in
Baltimore City's Residential Area by Months



$$K = \frac{\text{Production in Indicated Month}}{\text{Average of All Months' Production}}$$

FIGURE A - 5

Monthly Variation of Solid Waste Production, Baltimore City

Five Year Average, 1962 - 1966

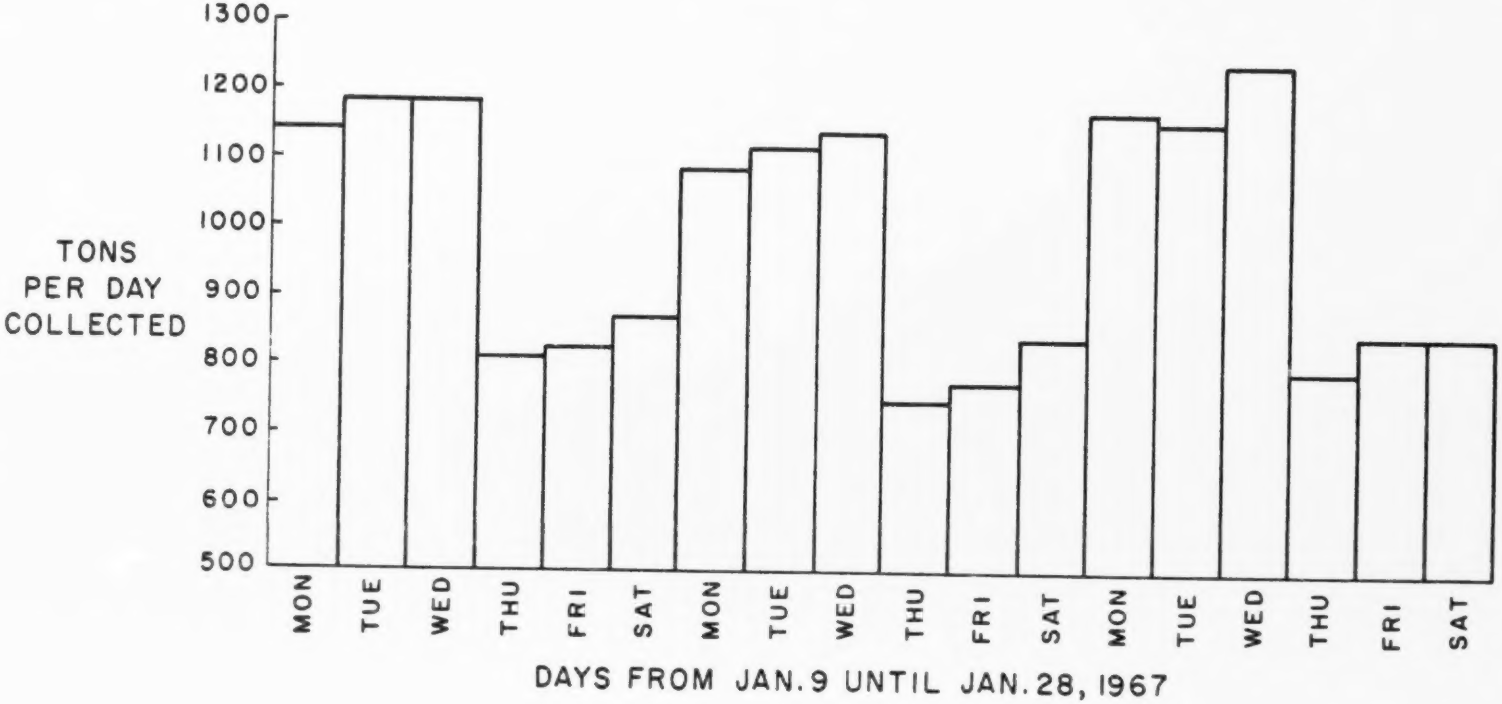
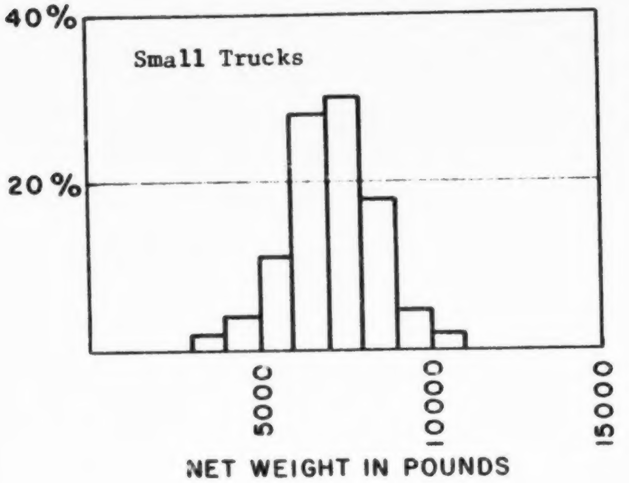
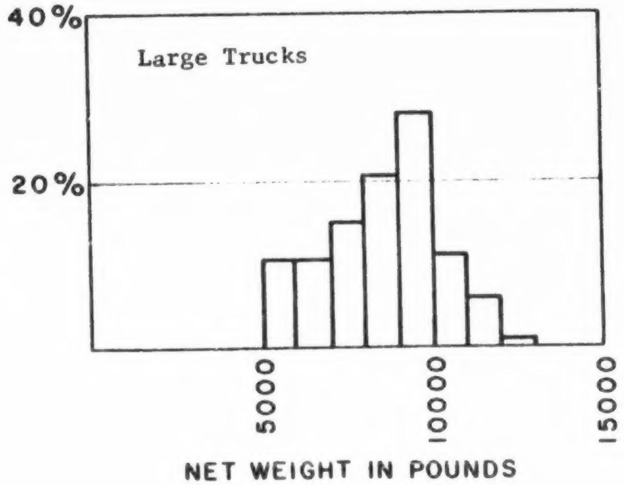


FIGURE A - 6

Daily Variance in Weights of Residential Solid Waste, Baltimore City





FIGURES A - 7 & A - 8

Distributions of Trucks' Full Weights

yards capacity trucks. The larger capacity trucks achieved only 79 percent of the compaction which was obtained by the smaller capacity trucks; the former having averaged compaction of 435 pounds per cubic yard and the latter 550 pounds per cubic yard. The daily weight of refuse per capita in Baltimore averages 1.95 pounds with a standard deviation of 0.09 pounds. These values were used throughout this study.

TRAFFIC

Distances and trip times were noted for 456 trips of collection trucks on Baltimore streets. These trips were equally divided between empty from the incinerator and full from the collection areas. Figure A-9 shows the distribution of these traffic speeds. Figure A-10 and A-11 show the same data, but have presented them in two histograms, one for empty conditions and one for full conditions.

A common claim for the smaller capacity trucks is that a reduction in haul time is realized with their use because of traffic maneuverability. An analysis of variance two way test was made on four cells of thirty data bits each to determine if significances were indicated of the effects of trucks capacity and loaded or empty condition, or interaction of the two, on traffic speeds. The four cells were:

a. 13 cubic yard capacity empty
b. 13 cubic yard capacity full
c. 20 cubic yard capacity empty
d. 20 cubic yard capacity full

The analysis of variance results are given in Table A-2; no significant differences were indicated in traffic speeds whether full or empty, or

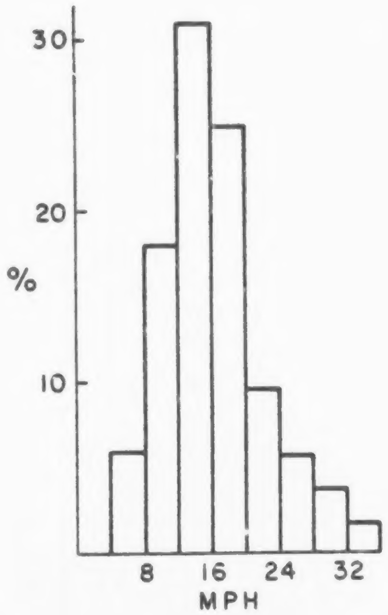


FIGURE A - 9

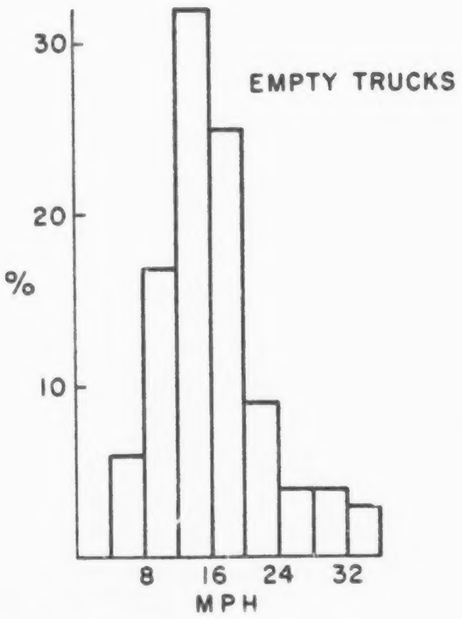


FIGURE A - 10

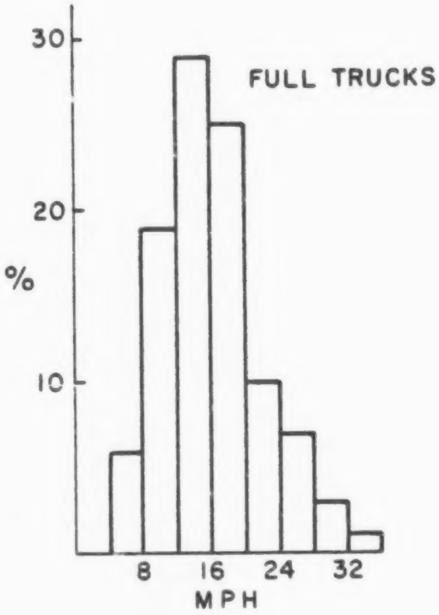


FIGURE A - 11

Traffic Speed Distributions

ANALYSIS OF VARIANCE TABLE

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Between empty and full condition	0.533	1	0.533	0.02
Between 13 yard and 20 yard sizes	2.700	1	2.700	0.08
Interaction	0.299	1	0.299	0.01
Residual	2931.27	116	25.27	
TOTAL	2934.8	119		

F (1,116) at 0.05 = 3.92

TABLE A-2

Test for Significance of Truck Size and Loaded Condition on Traffic Speed whether 13 or 20 cubic yard capacity.

Figure A-12 shows speed versus trip distance for 99 of the above 456 trips. The 99 were chosen randomly. It is noted that speeds are distributed heteroscedastically. Figure A-13 is a plot of logs of speeds versus distance for the same data and the ordinates, the log of speeds, are homoscedastic. The least-squares regression equation of log speed on distance is:

$$\text{Log Speed (mph)} = 0.978 + (0.0419 * \text{Distance in Miles})$$

The standard error of estimate is 0.1366

The index of correlation is 0.407

Figure A-13 shows this regression equation on an arithmetic ordinate scale.

It may be noted in Figures A-12 and A-13 that data extend only to a traffic distance of about fifteen miles. Beyond this value, it was assumed that logs of traffic speeds would vary normally around the upper value of log speed given by the equation for the fifteen mile distance.

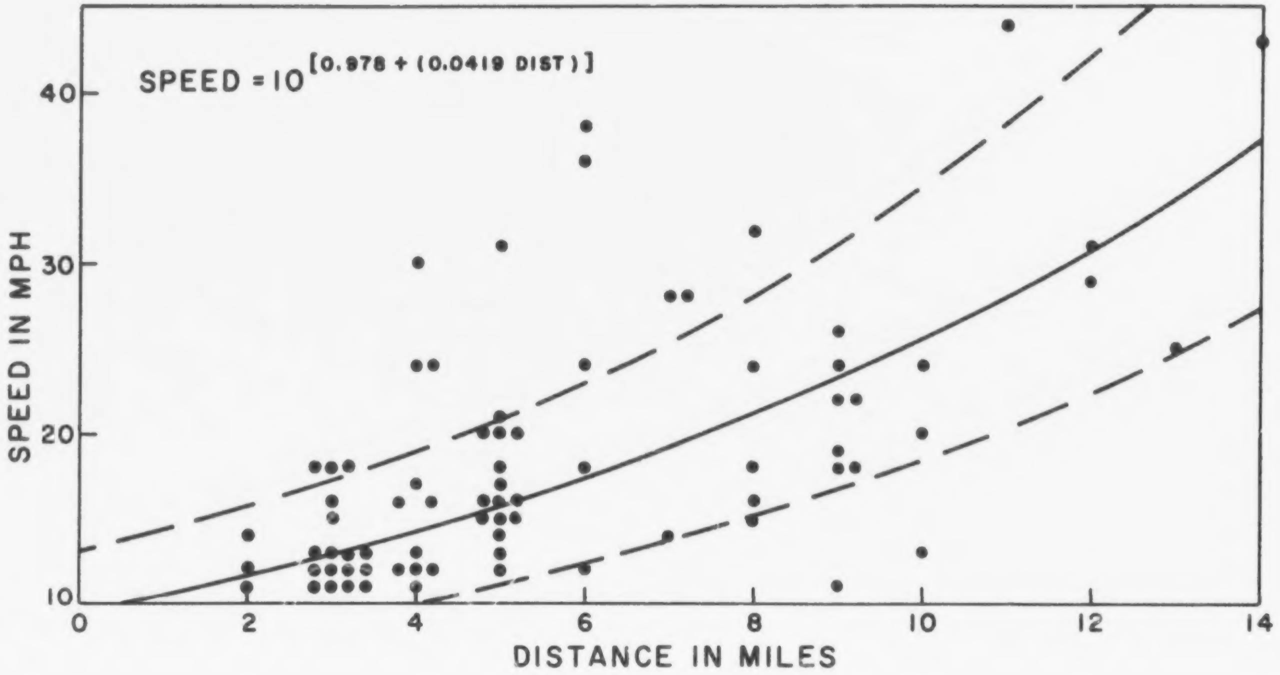


FIGURE A - 12

Least Squares Exponential Regression of Traffic Speed on Trip Distance

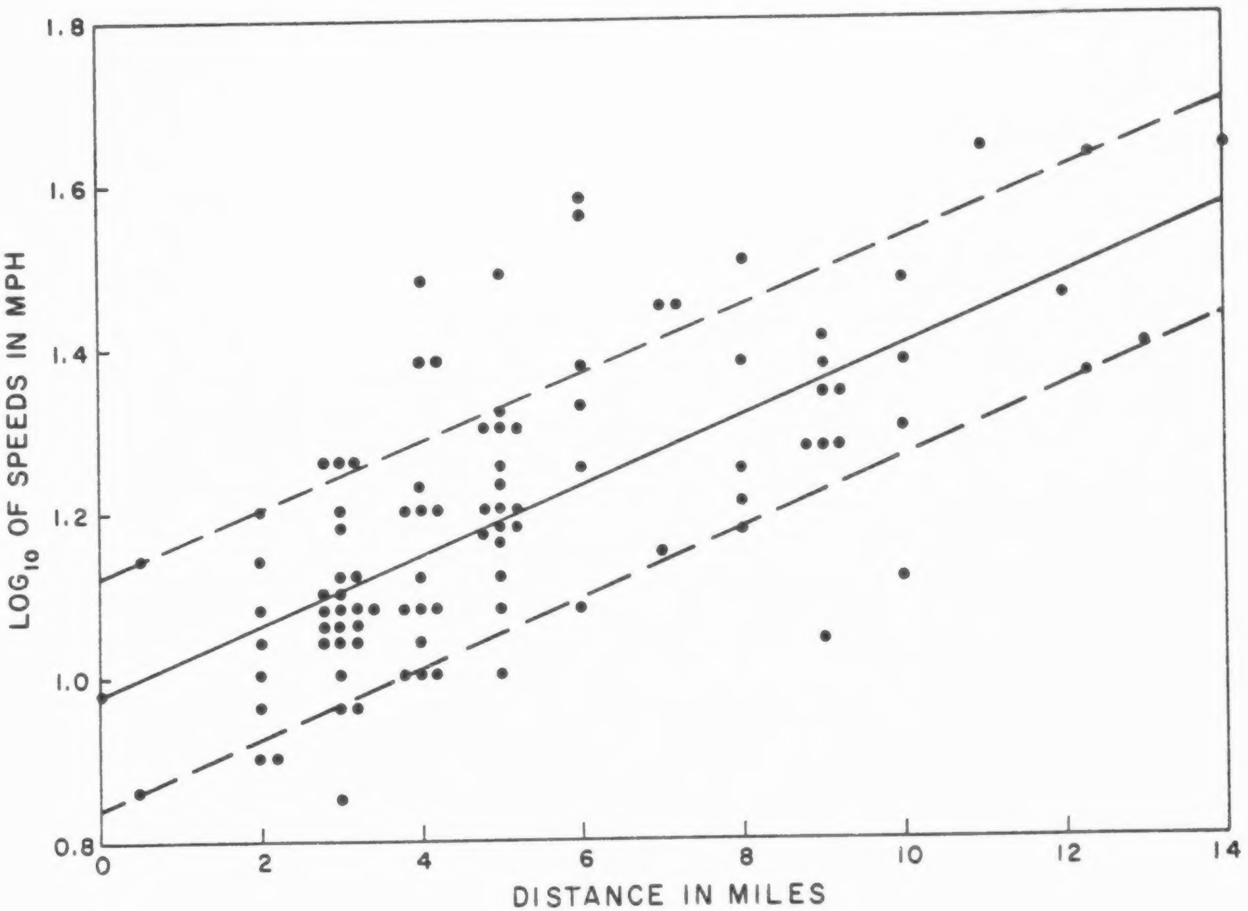


FIGURE A - 13

Least Squares Linear Regression of Log Traffic Speed on Trip Distance

COLLECTION

Baltimore is divided into four different areas, termed divisions, by its Bureau of Sanitation. The neighborhood types range from open high income areas, through middle income single family and apartment units, to very congested high density slums. The collection rate in pounds per hour appears to be low in the sparsely populated areas, becoming high as housing density increases and then seems to vary in extremely high housing density areas because of the crews' lack of work area for their activity. Logic also suggests that differences would exist in collection rates dependent on the number of laborers and the number of days since the last collection.

A great amount of data was collected to clarify the above points. During the period in which the field crews were keeping logs, 315 periods of collection were noted for total weight collected, time spent collecting, number of laborers on each truck, neighborhood type, and days since last collection. Decisions were then made of the type and number of distributions from which to draw in the models for realistic portrayal of collection activity.

The data from neighborhoods of housing densities greater than ten units per acre were first subjected to an analysis of variance two-way test to check the indicated significance of dense neighborhood types and collection frequency on collection rate. The test was conducted with 120 values of collection rates in units of pounds per hour. The values were taken randomly from the entire field data.

The analysis of variance results are given in Table A-3; the results show no significant difference indicated in collection rates because of difference in neighborhood types or days since last collection.

A second two-way analysis of variance test then was made using the same data plus two more cells with 20 data bits in each from neighborhood type 1 for both three and four days since last collection. These results are given in Table A-4 and show very significant difference indicated in collection rates because of the different situation of three days since last collection against four days since last collection.

Also this second test indicated significant differences in collection rates between that for neighborhood type 1 and those for neighborhood types 2, 3, and 4.

ANALYSIS OF VARIANCE TABLE

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Between collection frequencies	460.2	1	460.2	3.20
Between neighborhood types	177.9	2	88.9	0.6
Interaction	942.9	2	471.5	3.28
Residual	16,418.7	114	144.0	
TOTAL	17,999.8	119		

F (1,114) at 0.05 = 3.92
F (2,114) at 0.05 = 3.07

TABLE A-3

Test for Significance of Neighborhood Type and Collection
Frequency on Collection Rates
for
Neighborhoods of Greater Than 10 Housing Units per Acre

ANALYSIS OF VARIANCE TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Between collection frequencies	1,722.7	1	1,722.7	8.05
Between neighborhood types	3,355.5	3	1,118.5	5.24
Interaction	1,783.0	3	594.3	2.78
Residual	32,593.7	152	214.4	
TOTAL	39,454.9	159		

F (1,152) at 0.05 = 3.90
F (3,152) at 0.05 = 2.64

TABLE A-4

Test for Significance of Neighborhood Type and Collection Frequency
on Collection Rates
for
All Four Neighborhood Types

On the basis of this information, field data were incorporated into three histograms showing distributions rates for particular field conditions.

Figure A-14 shows the observed distribution of collection rates within neighborhood type 1 with three days having elapsed since last collection.

Figure A-15 shows the observed distribution of collection rates within neighborhood type 1 with four days since last collection.

Figure A-16 shows the observed distribution of collection rates within neighborhood types 2, 3, and 4. This histogram is applicable with crews with either two or three laborers and with either three or four days since last collection. Table A-3 showed no significant difference indicated in collection rates due to these sources of variance.

Figure A-17 shows the assumed distribution of collection rates within neighborhood type 1 with a crew of a driver and two laborers and with two days having elapsed since last collection. Figure A-18 shows the assumed distribution of collection rates within neighborhood type 2, 3, and 4 for the same conditions. The assumed distributions are used in the simulations for three times a week collection. The assumed

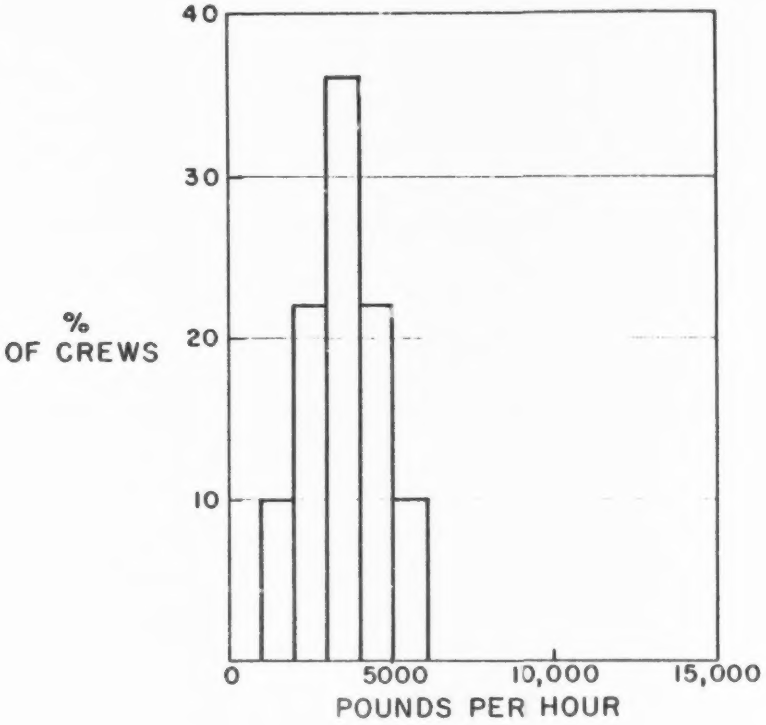


FIGURE A - 14

Observed Collection Rates, Neighborhood Type 1,

Three Days Since Last Collection

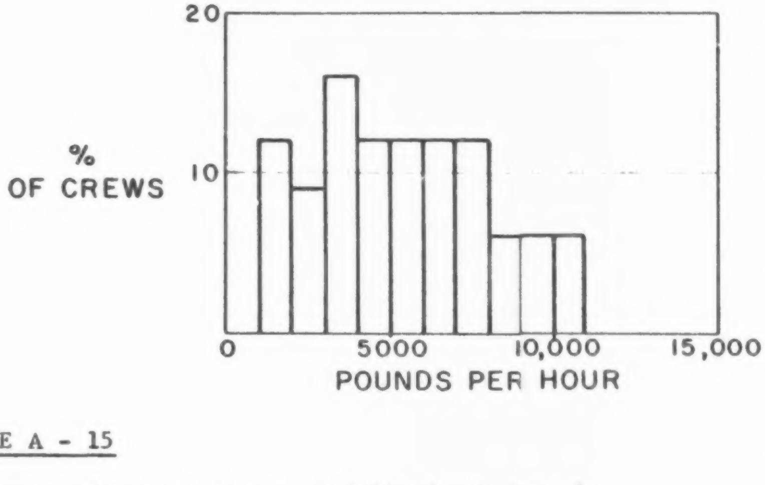


FIGURE A - 15

Observed Collection Rates, Neighborhood Type 1,

Four Days Since Last Collection

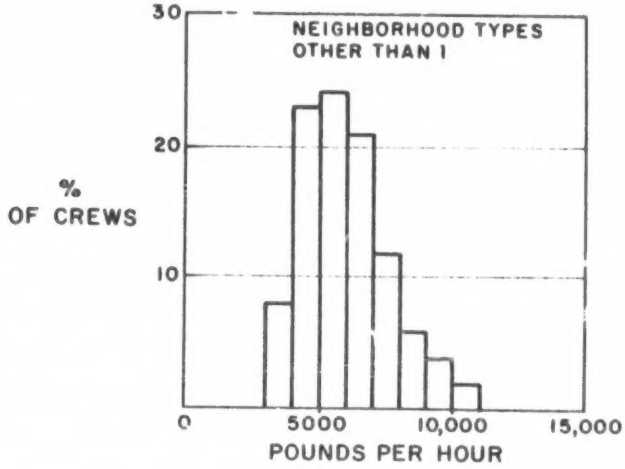


FIGURE A - 16

Observed Collection Rate, 3 & 4 Days Since Last Collection

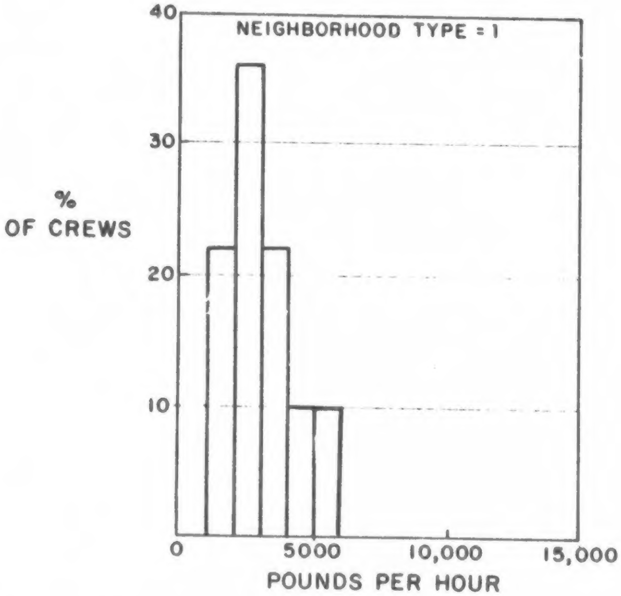


FIGURE A - 17

Assumed Collection Rate, 2 Days Since Last Collection

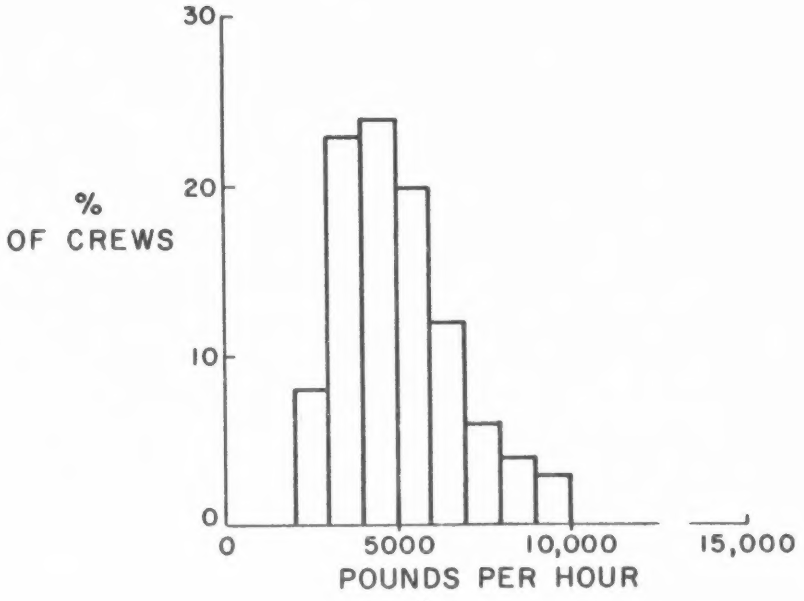


FIGURE A - 18

Assumed Collection Rate, Neighborhood Types Other Than 1, Two Days Since Last Collection distributions are similar in shape to the observed ones from the same neighborhood type and with the same number of laborers, but are shifted 1000 pounds per hour to the left because of the assumption of having only two days since the last collection rather than three. This condition would reduce the collection rate. No observed data were available either from Baltimore or from other cities for this condition.

The Baltimore field information included average speed in miles per hour of the trucks as they moved through the collection streets and alleys. These speeds were calculated by dividing the mileage covered by the truck while collecting by the elapsed time spent collection (Table A-5)

Table A-6 was not used in the models, but the information within it came from that from which the histograms of Figures A-17 and A-18 were prepared. These latter assumed collection rates for untested conditions. These data indicate the lessened production per man per hour of the three-man crew compared to the two-man crew for the densely populated areas. However, when three-man crew is used, Monday, Tuesday, and Wednesday, the work day in Baltimore averages about 40 minutes longer than that of the last three days of the week.

Neighborhood Types	Speeds in MPH											Total No. Trucks
	0 to 0.5	0.5 to 1.0	1.0 to 1.5	1.5 to 2.0	2.0 to 2.5	2.5 to 3.0	3.0 to 3.5	3.5 to 4.0	4.0 to 4.5	4.5 to 5.0	5.0 to 5.5	
1	0	1	1	6	7	6	1	0	0	0	0	22
2 & 3	0	21	19	10	4	4	2	1	3	3	0	67
4	0	47	37	18	12	5	8	6	2	1	0	136

TABLE A-5

Collection Speeds, Showing Distribution of Number of Trucks Within Designated Speed Intervals

Neighborhood Type	Two-Laborer Crew		Three-Laborer Crew	
	Lbs/Hr/Man	Lbs/Hr/Crew	Lbs/Hr/Man	Lbs/Hr/Crew
1	1,575 n=20	3,150 n=20	1,830 n=14	5,490 n=14
2	2,710 n=20	5,420 n=20	2,100 n=31	6,300 n=31
3	2,645 n=21	5,290 n=21	2,030 n=23	6,090 n=23
4	2,550 n=103	5,100 n=103	1,880 n=89	5,640 n=89

TABLE A-6

Collection Rates in Pounds per Hour per Man and Per Crew

DUMPING

The City of Baltimore has two incinerators, the newer termed the Pulaski Incinerator and the older the Reedbird Incinerator. The Pulaski has a rated capacity of 800 tons per day and the Reedbird 600 tons per day. The Pulaski has nine unloading docks and the Reedbird eight. All loads are weighed, and both incinerators accept commercial trucks for a fee.

Several half-days were spent observing the dumping activities. It was noted that queuing at the unloading docks seldom occurred unless there was a truck breakdown or difficulty with the scales. The commercial trucks without dumping or ejecting mechanisms often required a very long time (15 or 25 minutes) for unloading into the pits. The automatic ejector city trucks actually unloaded, not including moving and weighing, in about three minutes as compared to five minutes for the city dump-type trucks.

The histogram shown in Figure A-19 shows time intervals between truck arrivals at the incinerators. This represents data from 154 arrivals at Pulaski and 117 arrivals at Reedbird. These times of observation were

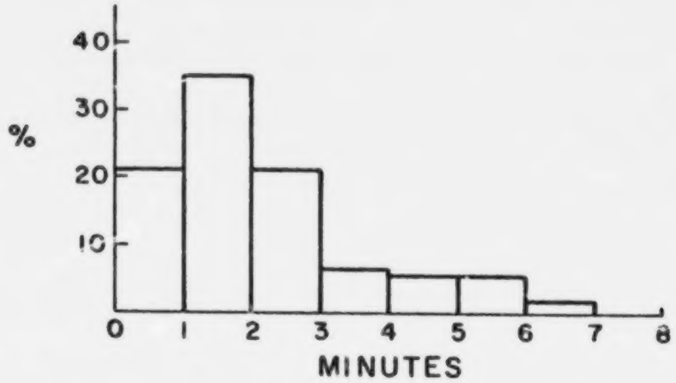


FIGURE A - 19

Time Interval between Truck Arrivals at Incinerators for "average to busy" conditions as estimated by the scale operators. The times were generally 9:30 to 11:30 AM and 1:00 to 2:00 PM. Figure A-20 shows "service time" for city trucks only at the two sites for 50 trucks at each site. "Service time" is elapsed time between the truck entering and leaving the incinerator yard. Field observations indicated approximately 16 percent of the trucks were commercial, and city records indicate that 14 percent of the tonnage handled is from commercial trucks. Table A-7 gives the data from incinerators from which Figure A-20 was prepared.

Figure A-20 is bimodal, as are the data for service times from both incinerators. This is due neither to sizes nor types of trucks, but rather due to some of the crews leaving their trucks while dumping to use the facilities at the site. When this "off-route" time was not used, the city trucks dumping times were massed around the left node.

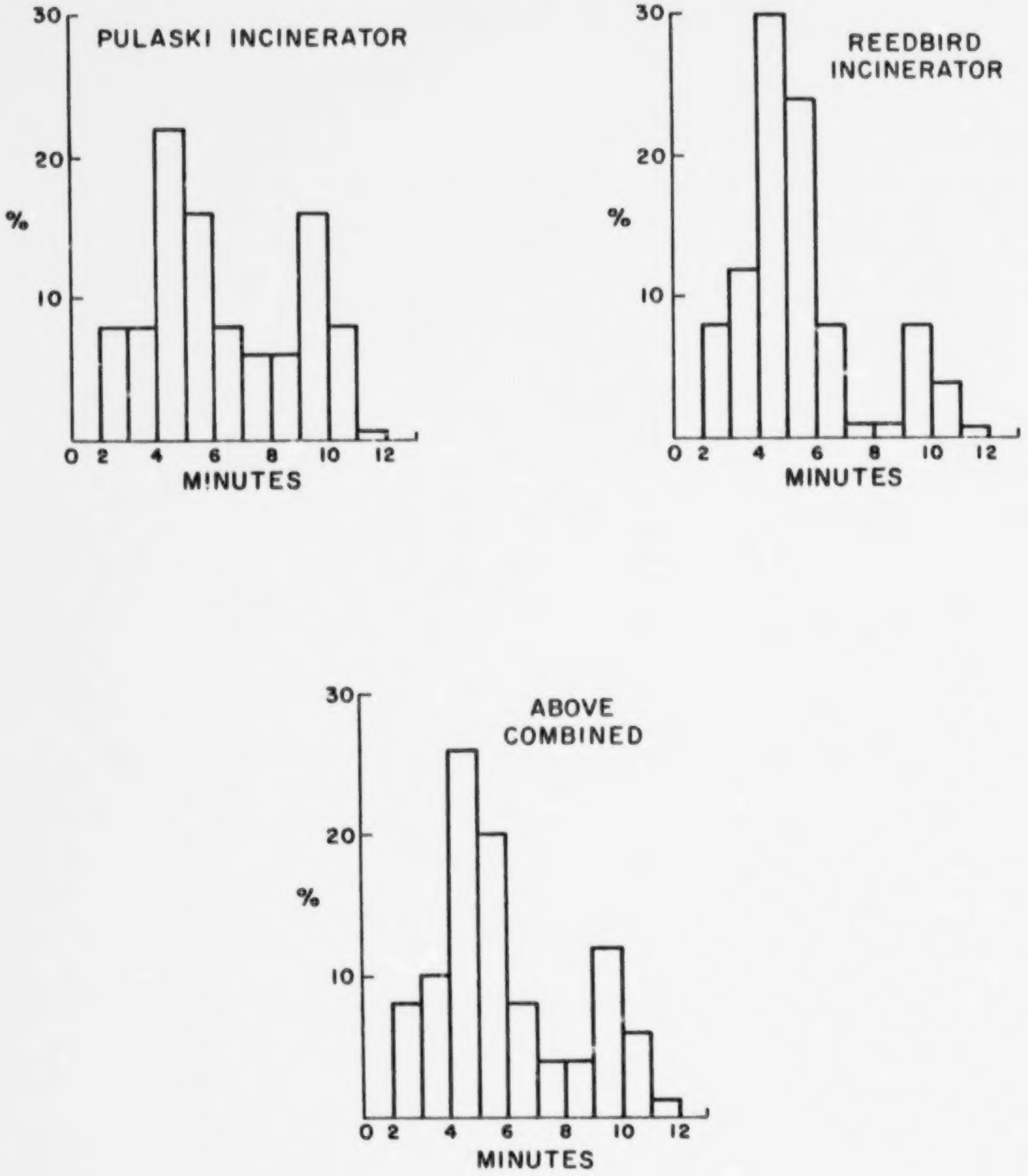


FIGURE A - 20

Incinerator Service Times

Service Time Interval In Minutes	Pulaski Site	Reedbird Site	Total
0-1	0	0	0
1-2	4	4	8
2-3	4	6	10
3-4	11	15	26
4-5	8	12	20
5-6	4	4	8
6-7	3	1	4
7-8	3	1	4
8-9	8	4	12
9-10	4	2	6
10-11	1	1	2
	50	50	100

TABLE A-7

Service Times at Baltimore Incinerators

APPENDIX B

DATA OTHER THAN BALTIMORE FIELD OBSERVATIONS

1. Transfer Stations

Information of the physical arrangements, the costs of operations, and operating policies of existing transfer stations were gathered so that the simulation model transfer station could hopefully duplicate existing successful ones.

Transfer station information was received from Chicago, Denver, New Orleans, Beverly Hills, Santa Monica, Reno, and Abilene, Texas. Particular values are given in Table B-1.

The New Orleans stations is unique in that overloaded or shut-down incinerators are used as transfer stations. The collection trucks dump directly into the incinerator pits; the incinerator crane then loads into a chute and on into trailers.

The trailers cost from $17,000 to $20,000, and the tractors between $11,500 and $15,000. The cities, excepting Abilene, Texas reported

City	Transfer Station Acres	Station Cost Dollars	Daily Operation in Tons	Number of Haul Trailers	Cu. Yd. Capacity of Haul Trailers	No. of Unloading Docks	One-way Haul Distance Miles	No. of Collection Trucks	Average Cu. Yd. Size of Collection Trucks
Chicago, Ill.	1.5	120,000	1,100	14	78	3	20.0	--	20
Denver, Col.	2.0	240,000	600*	4	60	2	12.5	15	20
Abilene, Texas	3.0	10,000	100	3	75**	1	7.0	--	--
Reno, Nev.	3.8	10,000	300	3	80	3	11.5	30	20
Santa Monica, Calif.	1.0	33,000	225	3	82	4	11.0	20	20
Beverly Hills, Calif.	1.1	125,000	150	3	105	1	11.0	17	--

* 1000 capacity

** compacter-type

TABLE B-I

Data from Existing Transfer Stations

little or no compaction within the trailers. Split level loading was done at all stations with the collection trucks either dumping directly into the trailer, directly into a chute, or onto a concrete ramp from where a bulldozer pushed the solid waste into a loading chute.

The cities of Reno and Beverly Hills were outspoken in the belief that their transfer stations were efficient and successful parts of their solid waste collection systems. Beverly Hills gave an operating cost on each tractor-trailer combination of $1.16 per mile, which includes depreciation.

2. Cost Information of Existing Collecting System

A number of cities answered questionaires relative to costs and policies of their collection systems. Table B-2 gives values. Comments on the replies follow:

Boston's collection is let by contract and the values shown for it are supplied by and applicable to a private firm.

Most of the cities which show no overtime pay give offtime, hour for hour, for crews overtime period. A number of cities for which the table shows overtime pay at the rate of time and a half give

City	Truck Driver's Hourly Rate	Laborer's Hourly Rate	Is Overtime Usually Paid?	At What Rate?	Cu. Yd. of Most Common Compacter Truck	Expected Life of Truck in Years	Fuel and Maintenance Cost per Mile for this Truck	Percentage of Trucks out for Repair
Atlanta	2.05	2.05	No	--	20	6	30¢	10
Birmingham	2.70	1.55	No	--	20	5	20¢	3-8
Boston	3.18	3.18	Yes	1 1/2	25	5	--	5
Chicago	3.75	3.57	Yes	1 1/2	20	6	--	20
Cleveland	2.49	2.28	No	--	20	8	--	10
Dallas	2.03	1.74	Yes	1 1/2	14	5	22¢	0-6
Denver	3.03	2.42	Yes	1 1/2	20	10	--	5
Detroit	2.96	2.70	Yes	1 1/2	16	8	30¢	10
Houston	2.10	1.98	No	--	16	3-8	15¢	5-15
New Orleans	1.56	1.35	No	--	20	7	--	20
Philadelphia	2.84	2.42	No	--	20	6	35¢	20-25
Pittsburgh	2.87	2.82	No	--	18	5	11¢	8
Seattle	3.83	3.78	Yes	1 1/2	17	8	--	3
Tampa	2.15	1.85	No	--	20	5-7	34¢	9

TABLE B-2

Data of Existing Collection Systems

double time pay for work exceeding ten hours in a single day.

Most cities showed a range of hourly wages reflecting longevity increases. The values shown in the table are maximum for the job.

Appendix C

DATA GATHERING FORMS

TRAFFIC SPEED DATA SHEET

To be completed by driver

1. Trip with truck empty

	Speedometer Mileage Reading is	Clock time is
On leaving incinerator or disposal area		
On arriving at collection area		

Weather is ☐ clear ☐ rain ☐ snow

3. Trip with truck full

	Speedometer Mileage Reading is	Clock time is
On leaving collection area		
On arriving at incinerator or collection area		

Weather is ☐ clear ☐ rain ☐ snow

To be completed by supervisor

3. City ____________________ 4. Date ____________________

5. Driver or truck identification ____________________

6. Truck type & capacity ____________________

7. Were these two trips on ☐ Mainly city streets or residential streets

☐ Mainly thoroughfares & highways

☐ About half & half

8. Comments ____________________

____

____

Signature of Supervisor

Solid Waste Collection Study
The Johns Hopkins University
Department of Environmental Engineering
513 Ames Hall, Baltimore, Md.

e-7¼

CITY OF BALTIMORE

COLLECTION SPEED DATA SHEET

To be completed by driver while in Collection Area

1.

	Clock time is	Speedometer Mileage Reading is
When emptying first can for this load		
When emptying last can can for this load		

2. Weather is ☐ clear ☐ rain ☐ snow

3. Collection is chiefly from ☐ front curb cans ☐ alley cans

4. Days since last collection ☐ 1 ☐ 2 ☐ 3 ☐ 4 or ☐

5. Crew size is the driver and ☐ 1 ☐ 2 ☐ 3 ☐ 4 men

6. Weight of this load is __________ pounds

To be completed by supervisor

7. Division ☐ NW ☐ NE ☐ West ☐ East

8. Borough No. _______

9. Task area of collection __________________

10. Date ________________________

11. Driver or truck identification ____________ ____________________

12. Truck type or capacity ____

13. Comments ____

____

____

Signature of Supervisor

Solid Waste Collection Study
The Johns Hopkins University
Department of Environmental Engineering
513 Ames Hall, Baltimore, Md.

Appendix D

COST CALCULATIONS FOR SEMIWEEKLY AND TRIWEEKLY COLLECTION, CHAPTER 4

RUN	NETYP	HAUL DIST	$ / TON	TONS	$
17	1	1	10.93	9.94	108.64
		4	11.36	8.81	100.08
		8	12.25	8.36	102.41
		12	13.22	7.51	99.28
		18	14.98	6.49	97.22
		24	15.67	6.54	102.48
18	2	1	5.71	17.12	97.76
		4	7.30	13.12	95.78
		8	8.38	11.70	98.05
		[illegible]	8.68	10.97	95.05
		18	9.57	9.58	91.69
		24	10.94	8.08	88.39
19	3	1	6.17	16.19	99.89
		4	7.36	13.37	98.40
		8	8.35	11.56	96.53
		12	8.67	11.00	95.37
		18	9.61	9.12	87.64
		24	10.34	8.58	88.72
20	4	1	6.05	16.48	99.70
		4	7.29	13.26	96.67
		8	8.39	11.50	96.49
		12	8.92	10.64	94.91
		18	9.87	9.43	93.07
		24	10.54	8.61	90.75

TABLE D-1

RUN	NETYP	HAUL DIST	$ / TON	TONS	$
		1	13.91	6.71	93.34
		4	16.53	6 00	99.18
21	1	8	16.62	5.52	91.74
		12	18.13	4.90	88.84
		18	19.81	4.42	87.56
		24	19.93	4.34	86.50
		1	8.24	11.61	95.67
		4	10.27	8.71	89.45
22	2	8	11.35	7.75	87.96
		12	12.07	7.19	86.78
		18	13.65	6.36	86.68
		24	16.06	5.39	86.56
		1	8.32	10.95	91.10
		4	10.06	8.81	88.63
23	3	8	11.44	7.67	87.75
		12	11.89	7.41	88.10
		18	14.36	6.05	86.88
		24	15.45	5.68	87.76
		1	8.07	10.91	88.04
		4	9.90	8.91	88.21
24	4	8	11.71	7.56	88.53
		12	12.14	7.23	87.77
		18	14.02	6.25	87.62
		24	15.63	5.57	87.06

TABLE D-2

RUN	NETYP	HAUL DIST	$ / TON	TONS	$
33	1	1	10.36	12.99	134.58
		4	11.08	10.82	119.89
		8	13.36	9.38	125.82
		12	12.79	9.13	116.77
		18	14.06	8.10	113.89
		24	16.16	6.98	112.80
34	2	1	7.13	17.43	124.28
		4	8.97	13.04	116.97
		8	10.25	11.63	119.21
		12	10.31	11.69	120.53
		18	11.61	9.24	107.28
		24	13.39	7.95	106.45
35	3	1	7.23	16.20	117.13
		4	9.42	13.05	122.93
		8	10.10	11.40	115.14
		12	10.12	11.34	114.76
		18	11.61	9.19	106.70
		24	12.82	8.42	107.94
36	4	1	7.30	15.62	114.03
		4	8.93	13.47	120.29
		8	10.01	11.66	116.72
		12	10.45	10.62	110.98
		18	11.96	9.94	118.88
		24	12.48	8.64	107.83

TABLE D-3

RUN	NETYP	HAUL DIST	$/ TON	TONS	$
37	1	1	10.76	9.61	103.40
		4	12.07	8.26	99.70
		8	14.30	7.01	100.24
		12	13.50	6.84	92.34
		18	14.98	6.17	92.43
		24	17.83	5.12	91.29
38	2	1	6.78	12.97	87.94
		4	8.94	9.75	87.16
		8	9.84	8.88	87.38
		12	9.78	8.89	86.94
		18	12.48	6.89	85.99
		24	14.54	6.00	87.24
39	3	1	7.23	12.12	87.63
		4	8.89	9.82	87.30
		8	10.14	8.49	86.09
		12	10.10	8.56	86.46
		18	12.38	6.93	85.79
		24	13.87	6.30	87.38
40	4	1	7.48	11.59	86.69
		4	8.83	10.02	88.48
		8	9.91	8.78	87.01
		12	10.86	7.93	86.12
		18	11.52	7.49	86.28
		24	13.47	6.50	87.56

TABLE D-4

NEIGHBORHOOD TYPE	FROM RUNS	HAUL DISTANCE	SUM OF TONS	SUM OF DOLLARS	$/TON
1	33 & 37	1	22.60	237.98	10.53
		4	18.28	219.59	12.01
		8	16.39	226.06	13.79
		12	15.97	209.11	13.09
		18	14.27	206.32	14.46
		24	12.10	204.09	16.87
2	34 & 38	1	30.40	212.22	6.98
		4	22.79	204.13	8.96
		8	20.51	206.59	10.07
		12	20.58	207.47	10.08
		18	16.13	193.27	11.98
		24	13.95	193.69	13.88
3	35 & 39	1	28.32	204.76	7.23
		4	22.87	210.23	9.19
		8	19.89	201.23	10.12
		12	19.90	201.22	10.12
		18	16.12	192.49	11.94
		24	14.72	195.32	13.27
4	36 & 40	1	27.21	200.72	7.38
		4	23.49	208.77	8.89
		8	20.44	203.73	9.97
		12	18.55	197.10	10.63
		18	17.93	205.16	11.77
		24	15.14	195.39	12.91

TABLE D-5

NEIGHBORHOOD TYPE	FROM RUNS	HAUL DISTANCE	SUM OF TONS	SUM OF DOLLARS	$/TON
1	17 & 21	1	23.36	295.52	12.65
		4	20.81	298.44	14.34
		8	19.40	285.89	14.74
		12	17.31	276.96	16.00
		18	15.33	272.34	17.77
		24	15.22	275.48	18.10
2	18 & 22	1	40.34	289.10	7.17
		4	30.54	274.68	8.99
		8	27.20	273.97	10.07
		12	25.35	268.61	10.60
		18	22.30	265.05	11.89
		24	18.86	261.51	13.87
3	19 & 23	1	38.09	282.09	7.41
		4	30.99	275.66	8.90
		8	26.90	272.03	10.11
		12	25.82	271.57	10.52
		18	21.22	261.40	12.32
		24	19.94	264.24	13.25
4	20 & 24	1	38.30	275.78	7.20
		4	31.08	273.09	8.79
		8	26.62	273.55	10.28
		12	25.10	270.45	10.78
		18	21.93	268.31	12.24
		24	19.75	267.87	13.41

TABLE D-6

ASSIGNED TASK	DISTANCE OF HAUL	RUN NUMBER	$/TON	TONS	DAY'S COST	RUN NUMBER	$/TON	TONS	DAY'S COST
μ	1	33	10.36	12.99	134.58	37	10.76	9.61	103.40
	4		11.08	10.82	119.89		12.07	8.26	99.70
	8		13.36	9.38	125.82		14.30	7.01	100.24
	12		12.79	9.13	116.77		13.50	6.84	92.34
	18		14.06	8.10	113.89		14.98	6.17	92.43
	24		16.16	6.98	112.80		17.83	5.12	91.29
$\mu - \sigma$	1	81	12.88	8.91	114.76	82	12.81	6.69	85.70
	4		14.77	7.82	115.50		15.11	5.81	87.79
	8		16.53	6.48	107.11		17.28	4.98	86.05
	12		17.90	6.33	113.31		18.12	4.74	85.89
	18		19.71	5.85	115.30		20.00	4.25	85.00
	24		21.25	4.91	104.34		23.09	3.63	83.82
$\mu + \sigma$	1	83	10.38	16.64	172.72	84	10.23	12.41	126.95
	4		11.05	14.55	160.78		12.83	10.82	138.82
	8		12.49	12.19	152.25		11.37	9.06	103.01
	12		12.88	11.77	151.60		13.08	8.90	116.41
	18		12.80	10.61	135.81		13.62	8.33	109.37
	24		14.27	9.07	129.43		15.78	6.82	107.62

TABLE D-7

Neighborhood Type 1

ASSIGNED TASK	DISTANCE OF HAUL	4 DSLC TON	3 DSLC TON	TONS	4 DSLC $	3 DSLC $	$	$/TON
	1	12.99	9.61	22.60	134.58	103.40	237.98	10.53
μ	4	10.82	8.26	18.28	119.89	99.70	219.59	12.01
	8	9.38	7.01	16.39	125.82	100.24	226.06	13.79
Runs	12	9.13	6.84	15.97	116.77	92.34	209.11	13.09
33 & 37	18	8.10	6.17	14.27	113.89	92.43	206.32	14.46
	24	6.98	5.12	12.10	112.80	91.29	204.09	16.87
	1	8.91	6.69	15.60	114.76	85.70	200.46	12.85
μ - σ	4	7.82	5.81	13.63	115.50	87.79	203.29	14.91
	8	6.48	4.98	11.46	107.11	86.05	193.16	16.85
Runs	12	6.33	4.74	11.07	113.31	85.89	199.20	17.99
81 & 82	18	5.85	4.25	10.10	115.30	85.00	200.30	19.83
	24	4.91	3.63	8.54	104.34	83.82	188.16	22.03
	1	16.64	12.41	29.05	172.72	126.95	299.67	10.31
μ + σ	4	14.55	10.82	25.37	160.78	138.82	299.60	11.81
	8	12.19	9.06	21.25	152.25	103.01	255.26	12.01
Runs	12	11.77	8.90	20.67	151.60	116.41	268.01	12.97
83 & 84	18	10.61	8.03	18.64	135.81	109.37	245.18	13.15
	24	9.07	6.82	15.89	129.43	107.62	237.05	14.92

TABLE D - 8

Neighborhood Type 1

ASSIGNED TASK	DISTANCE OF HAUL	RUN NUMBER	$/TON	TONS	DAY'S COST	RUN NUMBER	$/TON	TONS	DAY'S COST
μ	1	34	7.13	17.43	124.28	38	6.78	12.97	87.94
	4		8.97	13.04	116.97		8.94	9.75	87.94
	8		10.25	11.63	119.21		9.84	8.88	87.38
	12		10.31	11.69	120.53		9.78	8.89	86.94
	18		11.61	9.24	107.28		12.48	6.89	85.99
	24		13.39	7.95	106.45		14.54	6.00	87.24
$\mu + \sigma$	1	52	7.37	19.67	144.97	72	6.27	14.65	91.86
	4		9.31	14.86	138.35		8.17	11.15	91.10
	8		9.64	13.66	131.68		8.91	10.26	91.42
	12		9.91	13.40	131.79		9.07	10.06	91.24
	18		11.39	10.59	120.62		11.03	7.86	86.70
	24		12.18	9.28	113.03		12.81	6.86	87.88
$\mu - \sigma$	1	51	7.79	14.58	113.58	71	7.88	10.95	86.29
	4		9.67	11.09	107.24		10.25	8.29	84.97
	8		11.26	10.01	112.71		11.36	7.52	85.43
	12		11.06	10.09	111.60		11.32	7.57	85.69
	18		13.22	7.93	104.83		14.37	5.90	84.78
	24		15.64	6.74	105.41		16.66	5.00	83.30
$\mu + 3\sigma$	1	53	7.09	24.75	175.48	73	5.82	18.66	108.60
	4		8.76	18.99	166.35		7.60	14.21	108.00
	8		10.15	17.08	173.36		7.95	12.64	100.49
	12		10.05	16.90	169.85		8.13	12.72	103.41
	18		9.94	13.38	133.00		9.72	10.11	98.27
	24		12.01	11.45	137.51		10.72	8.57	91.87

TABLE D - 9

ASSIGNED TASK	DISTANCE OF HAUL	4 DSLC TON	3 DSLC TON	TONS	4 DSLC $	3 DSLC $	$	$/TON
	1	17.43	12.97	30.30	124.28	87.94	212.22	6.98
μ	4	13.04	9.75	22.79	116.97	87.16	204.13	8.96
	8	11.63	8.88	20.51	119.21	87.38	206.59	10.07
Runs	12	11.69	8.89	20.58	120.53	86.94	207.47	10.08
34 & 38	18	9.24	6.89	16.13	107.28	85.99	193.27	11.98
	24	7.95	6.00	13.95	106.45	87.24	193.69	13.88
	1	19.67	14.65	34.32	144.97	91.86	236.83	6.90
μ + σ	4	14.86	11.15	26.01	138.35	91.10	229.45	8.82
	8	13.66	10.26	23.92	131.69	91.42	223.10	9.33
Runs	12	13.40	10.06	23.46	132.79	91.24	224.03	9.54
52 & 72	18	10.59	7.86	18.45	120.62	86.70	207.32	11.24
	24	9.28	6.86	16.14	113.03	87.88	200.91	12.45
	1	14.58	10.95	25.53	113.58	86.29	199.87	7.83
μ - σ	4	11.09	8.29	19.38	107.24	84.97	192.21	9.91
	8	10.01	7.52	17.53	112.71	85.43	198.14	11.30
Runs	12	10.09	7.57	17.66	111.60	85.69	197.29	11.17
51 & 71	18	7.93	5.70	13.83	104.83	84.78	189.61	13.70
	24	6.74	5.00	11.74	105.41	83.30	188.71	16.07
	1	24.75	18.66	43.41	175.48	108.60	284.08	6.54
μ + 3σ	4	18.99	14.21	33.20	166.35	108.00	274.35	8.26
	8	17.08	12.64	29.72	173.36	100.49	273.85	9.21
Runs	12	16.90	12.72	29.62	169.85	103.41	273.26	9.23
53 & 73	18	13.38	10.11	23.49	133.00	98.27	231.27	9.85
	24	11.45	8.57	20.02	137.51	91.87	229.38	11.46

TABLE D - 10

Neighborhood Type 2

ASSIGNED TASK	DISTANCE OF HAUL	RUN NUMBER	$/TON	TONS	DAY'S COST	RUN NUMBER	$/TON	TONS	DAY'S COST
μ	1	35	7.23	16.20	117.13	39	7.23	12.12	87.63
	4		9.42	13.05	122.93		8.89	9.82	87.30
	8		10.10	11.40	115.14		10.14	8.49	86.09
	12		10.12	11.34	114.76		10.10	8.56	86.46
	18		11.61	9.19	106.70		12.38	6.93	85.79
	24		12.82	8.42	107.94		13.87	6.30	87.38
$\mu + \sigma$	1	56	7.18	18.82	135.13	76	6.55	14.08	92.22
	4		9.19	15.04	138.22		8.09	11.17	90.37
	8		9.47	13.16	124.63		9.13	9.82	89.66
	12		9.87	13.07	129.00		9.38	9.76	91.55
	18		10.88	10.49	114.13		11.03	7.90	87.14
	24		12.59	9.58	120.61		12.29	7.20	88.49
$\mu - \sigma$	1	55	7.91	13.97	110.50	75	8.25	10.39	85.72
	4		9.76	11.15	108.82		10.19	8.35	85.09
	8		11.19	9.56	106.98		11.80	7.29	86.02
	12		11.22	9.54	107.04		11.81	7.24	85.50
	18		13.70	7.69	105.35		14.42	5.89	84.93
	24		15.02	7.06	106.04		15.91	5.29	84.16
$\mu + 3\sigma$	1	57	7.35	23.73	174.42	77	5.59	17.69	98.88
	4		8.90	19.08	169.81		7.76	14.32	111.12
	8		9.72	16.51	160.48		8.29	12.29	101.88
	12		10.41	16.30	169.48		7.92	12.29	97.34
	18		10.23	13.16	134.62		9.74	9.99	97.30
	24		12.46	12.21	152.14		9.86	9.19	90.61

TABLE D - 11

ASSIGNED TASK	DISTANCE OF HAUL	4 DSLC TON	3 DSLC TON	TONS	4 DSLC $	3 DSLC $	$	$/TON
μ	1	16.20	12.12	28.32	117.13	87.63	204.76	7.23
	4	13.05	9.82	22.87	122.93	87.30	210.23	9.19
Runs	8	11.40	8.49	19.89	115.14	86.09	201.23	10.12
35 & 39	12	11.34	8.56	19.90	114.76	86.46	201.22	10.12
	18	9.19	6.93	16.12	106.70	85.79	192.49	11.94
	24	8.42	6.30	14.72	107.94	87.38	195.32	13.27
	1	18.82	14.08	32.90	135.13	92.22	227.35	6.91
μ + σ	4	15.04	11.17	26.21	138.22	90.37	228.59	8.72
Runs	8	13.16	9.82	22.98	124.63	89.66	214.29	9.33
56 & 76	12	13.07	9.76	22.83	129.00	91.55	220.55	9.66
	18	10.49	7.90	18.39	114.13	87.14	208.27	11.33
	24	9.58	7.20	16.78	120.61	88.49	209.10	12.46
	1	13.97	10.39	24.36	110.50	85.72	196.22	8.05
μ − σ	4	11.15	8.35	19.50	108.82	85.09	193.91	9.94
Runs	8	9.56	7.29	16.85	106.98	86.02	193.00	11.45
55 & 75	12	9.54	7.24	16.78	107.04	85.50	192.54	11.47
	18	7.69	5.89	13.58	105.35	84.93	190.28	14.01
	24	7.06	5.29	12.35	106.04	84.16	190.20	15.38
	1	23.73	17.69	41.42	174.42	98.88	273.30	6.60
μ + 3σ	4	19.08	14.32	33.40	169.81	111.12	280.93	8.41
Runs	8	16.51	12.29	28.80	160.98	101.88	262.36	9.27
57 & 77	12	16.30	12.29	28.59	169.68	97.34	267.02	9.34
	18	13.16	9.99	25.15	134.62	97.30	231.92	10.02
	24	12.21	9.19	21.40	152.14	90.61	242.75	11.34

TABLE D - 12

Neighborhood Type 3

Appendix E

RESULTS FROM MODEL 3

RUN NUMBER	COLLECTION FREQUENCY	NO. OF SUBAREAS	TRANSFER STATION?	DISTANCE TO DISPOSAL SITE	OVERTIME PAID?	NUMBER OF ROUTES	NUMBER OF TRUCKS
1	2	13	y	24	y	71	24
2	2	13	n	24	y	117	39
3	3	13	y	24	y	59	30
4	3	13	n	24	y	91	46
5	2	13	y	8	y	71	24
6	2	13	n	8	y	84	28
7A	3	13	y	8	y	59	30
7B	3	13	y	8	y	59	30
7C	3	13	y	8	y	59	30
7D	3	13	y	8	y	59	30
7E	3	13	y	8	y	59	30
8	3	13	n	8	y	68	34
9	2	13	y	16	y	71	24
10	2	13	n	16	y	105	35
11	3	13	y	16	y	59	30
12	3	13	n	16	y	84	42
13	2	13	y	4	y	71	24
14	2	13	n	4	y	73	25

TABLE E - 1 (1 of 2)

RUN NUMBER	COLLECTION FREQUENCY	NO. OF SUBAREAS	TRANSFER STATION?	DISTANCE TO DISPOSAL SITE	OVERTIME PAID?	NUMBER OF ROUTES	NUMBER OF TRUCKS
15	3	13	y	4	y	59	30
16	3	13	n	4	y	60	30
17	2	13	n	9	n	87	29
18	2	13	n	9	n	87	29
19	3	13	n	9	n	71	36
20	3	13	n	9	n	71	36
21	2	13	y	4	y	71	24
22	2	13	y	16	y	71	24
23	2	13	y	24	y	71	24
24	2	13	y	8	y	71	24
25	3	13	y	8	y	59	30
26	2	8	y	12	y	39	13
27	2	5	y	12	y	30	10
28	3	13	y	8	y	59	30
29	3	13	y	8	y	59	30
31	2	4	y	12	y	20	7
32	2	4	y	12	y	23	8
33	2	5	y	12	y	26	9

TABLE E - 1 (2 of 2)

RUN NUMBER	WEEK'S TONNAGE	TOTAL COST $	COLLECTION $/TON	TRANSFER STATION $/TON	TOTAL $/TON
1	1544.	17,106.	9.08	2.00	11.08
2	1538.	22,157.	----	----	14.01
3	1539.	18,178.	9.73	2.08	11.81
4	1533.	23,118.	----	----	15.08
5	1537.	16,247	9.03	1.54	10.57
6	1543.	16,622.	----	----	10.77
7A	1537.	17,490.	9.81	1.57	11.38
7B	1533.	17,362.	9.76	1.57	11.33
7C	1538.	17,532.	9.84	1.46	11.40
7D	1530.	17,260.	9.72	1.56	11.28
7E	1546.	17,558.	9.81	1.55	11.36
8	1530.	17,683.	----	----	11.56
9	1547.	16,480.	9.01	1.64	10.65
10	1534.	19,222.	----	----	12.53
11	1536.	17,652.	9.75	1.74	11.49
12	1533.	20,420.	----	----	13.32
13	1550.	15,960.	9.06	1.23	10.30
14	1545.	14,643.	----	----	9.48
15	1543.	17,205.	9.81	1.34	11.15
16	1538.	15,847	----	----	10.31
17	1543.	16,461	----	----	10.67
18	1527.	16,348	----	----	10.70
19	1540.	17,899.	----	----	11.62
20	1536.	17,886.	----	----	11.65
21	1539.	15,870.	9.04	1.27	10.31
22	1545.	16,042.	8.97	1.42	10.38
23	1537.	16,433.	9.09	1.60	10.69
24	1537.	16,239.	9.04	1.53	10.57
25	1543.	17,501.	9.79	1.55	11.34
26	839.	9,289.	9.18	1.90	11.08
27	703.	7,334.	8.36	2.07	10.43
28	1538.	17,424.	9.82	1.51	11.33
29	1547.	17,796.	9.86	1.64	11.50
31	432.	5,226.	9.14	2.97	12.11
32	564.	5,665.	7.73	2.32	10.05
33	543.	6,678.	9.81	2.48	12.30

TABLE E - 2

RUN NUMBER	%TIME WHICH CREW SPENT IN				LENGTH OF WORKDAY IN HOURS			
	COLLECTION,	TRAFFIC	DISPOSAL	OFFROUTE	AVE.	SIGMA	MAX.	MIN.
1	60	14	5	21	6.8	1.5	15.3	4.3
2	38	35	3	24	6.4	1.2	15.1	3.8
3	59	12	4	25	6.2	1.4	11.6	3.9
4	39	32	2	26	6.2	1.4	12.6	3.3
5	60	14	5	21	6.7	1.4	12.5	4.3
6	50	27	3	21	6.9	1.5	15.5	4.7
7A	59	12	4	25	6.2	1.5	12.4	3.4
7B	58	12	4	26	6.1	1.5	11.2	3.2
7C	58	12	4	26	6.2	1.6	12.8	3.3
7D	57	12	5	26	6.1	1.4	11.5	3.6
7E	59	12	4	25	6.2	1.6	13.1	3.1
8	51	23	3	23	6.5	1.4	11.4	3.1
9	59	14	5	22	6.7	1.4	11.7	3.7
10	42	26	3	29	5.8	1.3	14.9	2.6
11	58	12	4	26	6.2	1.5	13.0	2.9
12	43	23	3	31	5.6	1.2	9.8	3.0
13	60	14	5	21	6.8	1.5	12.9	3.7
14	56	21	4	19	7.0	1.4	11.3	4.0

TABLE E - 3 (1 of 2)

RUN NUMBER	% TIME WHICH CREW SPENT IN				LENGTH OF WORKDAY IN HOURS			
	COLLECTION,	TRAFFIC	DISPOSAL	OFFROUTE	AVE.	SIGMA	MAX.	MIN.
15	58	12	4	26	6.2	1.6	14.1	3.2
16	57	18	3	22	6.6	1.5	12.2	3.4
17	49	27	3	21	6.8	1.5	13.7	4.2
18	48	27	3	23	6.6	1.3	11.4	4.3
19	49	24	3	24	5.4	1.5	11.4	3.6
20	49	24	3	24	6.4	1.6	14.0	3.4
21	61	14	5	21	6.8	1.4	14.0	3.5
22	59	14	5	22	6.7	1.5	15.1	3.7
23	60	14	5	21	6.7	1.5	12.6	4.3
24	60	14	4	22	6.6	1.4	12.0	3.7
25	60	12	3	25	6.2	1.6	12.1	3.3
26	61	11	4	24	6.5	2.1	17.2	3.6
27	66	8	4	22	6.6	1.6	12.0	4.2
28	59	12	4	25	6.2	1.5	11.8	3.3
29	58	12	5	25	6.3	1.6	11.9	3.3
31	62	10	4	24	6.5	2.1	14.6	3.7
32	63	10	5	23	6.5	1.2	9.1	4.2
33	64	11	4	21	6.9	2.0	13.2	3.8

TABLE E - 3 (2 of 2)

RUN NUMBER	NUMBER OF TRUCK BREAKDOWNS	NUMBER OF TRUCK TRIPS	TRUCK MILEAGE IN COLLECTION	TRUCK MILEAGE IN TRAFFIC	TOTAL TRUCK MILEAGE
1	0	411	2024	1847	3871
2	23	452	2039	21696	23735
3	2	408	3083	1835	4918
4	22	475	3149	22800	25949
5	1	411	1956	1841	3797
6	5	410	1962	6560	8522
7A	2	412	3071	1857	4928
7B	1	408	3074	1839	4903
7C	4	408	3118	1845	4963
7D	0	407	3249	1835	5084
7E	0	415	3137	1871	5008
8	7	422	3105	6752	9857
9	3	417	2053	1875	4928
10	9	435	2053	13920	15073
11	2	406	3200	1833	5033
12	12	456	3198	14592	17790
13	0	415	1996	1866	3862
14	3	409	2020	3272	5292
15	1	415	3147	1882	5029
16	0	411	3034	3288	6322
17	5	417	2003	7506	9509
18	10	414	1978	7452	9430
19	10	444	3094	7992	11086
20	10	440	3020	7920	10920
21	0	407	2065	1819	3884
22	2	410	2103	1840	3943
23	2	410	2005	1826	3831
24	2	410	2043	1828	3871
25	2	414	3039	1861	4900
26	0	229	1340	765	2105
27	0	191	805	400	1205
28	0	408	3155	1838	4993
29	3	416	2941	1883	4824
31	0	119	668	330	998
32	1	153	435	380	815
33	0	145	982	527	1509

TABLE E - 4

RUN	DAILY WEIGHT, TONS		DAILY COSTS, $			
NUMBERS	MONDAY	FRIDAY	MONDAY	FRIDAY	C/W*	TS?*
1	298	222	3402	2509	2	Y
2	288	220	4008	3246	2	N
3	335	222	3302	2968	3	Y
4	336	224	4227	3705	3	N
5	299	222	3137	2383	2	Y
6	289	218	3478	2293	2	N
7A	336	221	3094	2912	3	Y
7B	337	222	311.0	2828	3	Y
7C	334	227	3242	2911	3	Y
7D	330	227	3149	2833	3	Y
7E	340	221	3088	2892	3	Y
8	325	220	3115	2931	3	N
9	301	225	3184	2518	2	Y
10	294	220	3544	2813	2	N
11	336	225	3258	2891	3	Y
12	329	218	3575	3340	3	N
13	302	219	2957	2430	2	Y
14	301	215	2873	2028	2	N
15	336	225	3210	2737	3	Y
16	334	221	2943	2520	3	N
17	295	224	3112	2396	2	N
18	288	221	3057	2374	2	N
19	338	224	3204	2914	3	N
20	342	224	3167	2960	3	N
21	298	224	3021	2306	2	Y
22	300	226	3072	2340	2	Y
23	302	222	3132	2419	2	Y
24	295	221	3111	2346	2	Y
25	338	223	3231	2816	3	Y
26	162	121	1872	1289	2	Y
27	136	102	1318	1068	2	Y
28	332	222	3071	2890	3	Y
29	336	225	3460	2842	3	Y
31	88	64	1184	742	2	Y
32	111	84	1089	856	2	Y
33	109	78	1468	984	2	Y

C/W = Collections per week
TS? = Transfer Station, Yes or No

TABLE E - 5

PERCENTAGE OF TIME THAT QUEUES WERE IN THE INDICATED CONDITIONS

	RUN 1		RUN 3		RUN 5		RUN 7A	
	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2
NO TRUCKS	60.2	64.8	59.4	66.4	61.0	66.7	58.4	68.8
ONE TRUCK	26.4	27.1	27.5	25.0	29.4	26.1	28.3	25.0
TWO TRUCKS	9.9	6.8	9.8	7.2	7.9	6.4	11.1	5.8
THREE TRUCKS	3.0	1.2	3.2	1.3	1.5	0.8	2.1	0.5
FOUR TRUCKS	0.4	0.1	0.1	0.1	0.2	0	0.1	0
FIVE TRUCKS	0	0	0	0	0	0	0	0

	RUN 7B		RUN 7C		RUN 7D		RUN 7E	
	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2
NO TRUCKS	60.3	66.5	63.7	66.6	55.4	62.1	60.6	67.3
ONE TRUCK	27.4	26.0	24.1	23.3	28.6	26.6	29.3	26.9
TWO TRUCKS	9.6	6.3	10.4	8.9	11.2	8.8	8.8	5.3
THREE TRUCKS	2.1	1.0	1.9	1.1	3.6	1.8	1.2	0.5
FOUR TRUCKS	0.6	0.3	0	0	1.1	0.6	0.1	0
FIVE TRUCKS	0	0	0	0	0	0	0	0

	RUN 9		RUN 11		RUN 13		RUN 15	
	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2
NO TRUCKS	57.3	65.8	59.7	62.0	62.7	65.0	59.7	63.7
ONE TRUCK	30.6	24.9	27.2	28.2	25.2	25.9	26.0	26.8
TWO TRUCKS	8.9	7.3	10.1	8.0	10.1	8.2	10.9	7.9
THREE TRUCKS	3.1	1.7	2.8	1.9	1.8	0.8	3.3	1.6
FOUR TRUCKS	0.1	0.3	0.2	0	0.3	0.1	0.2	0
FIVE TRUCKS	0	0	0	0	0	0	0	0

TABLE E - 6 (1 of 2)

PERCENTAGE OF TIME THAT QUEUES WERE IN THE INDICATED CONDITIONS

	RUN 21		RUN 22		RUN 23		RUN 26	
	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2
NO TRUCKS	59.2	66.1	60.3	63.0	60.3	66.8	75.3	82.8
ONE TRUCK	28.6	27.5	26.3	26.0	28.4	26.0	22.3	15.9
TWO TRUCKS	10.6	5.5	10.5	10.0	9.7	6.9	2.1	1.3
THREE TRUCKS	1.3	1.0	2.9	1.0	1.6	0.2	0.3	0
FOUR TRUCKS	0.3	0	0	0	0	0	0	0
FIVE TRUCKS	0	0	0	0	0	0	0	0

	RUN 27		RUN 28		RUN 29		RUN 31	
	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2
NO TRUCKS	76.2	87.2	60.1	63.4	61.1	65.3	83.1	91.9
ONE TRUCK	22.1	12.8	25.8	26.2	24.3	24.4	16.6	8.1
TWO TRUCKS	1.7	0	10.6	8.2	10.3	7.3	0.2	0
THREE TRUCKS	0	0	3.1	1.9	3.2	2.4	0	0
FOUR TRUCKS	0	0	0.4	0.3	1.2	0.7	0	0
FIVE TRUCKS	0	0	0	0	0	0	0	0

	RUN 32		RUN 33	
	QUEUE 1	QUEUE 2	QUEUE 1	QUEUE 2
NO TRUCKS	74.9	89.6	82.8	92.9
ONE TRUCK	24.5	10.4	16.9	7.0
TWO TRUCKS	0.6	0	0.3	0
THREE TRUCKS	0	0	0	0
FOUR TRUCKS	0	0	0	0
FIVE TRUCKS	0	0	0	0

TABLE E - 6 (2 of 2)

RUN NUMBER	NO. OF TRUCKS	TRUCKS' MINUTES AT DISPOSAL		GETTING INDICATED NUMBER OF OVERTIME HOURS DURING WEEK		
		AVE.	MAX.	ONE	TWO	TWO
1	24	8.3	26	15	7	3
2	39	6.1	12	4	4	4
3	30	7.8	28	14	13	1
4	46	6.1	12	18	3	4
5	24	7.4	23	14	3	5
6	28	5.9	12	18	2	6
7A	30	7.6	21	12	7	2
7B	30	8.1	29	14	2	2
7C	30	7.9	23	13	6	3
7D	30	8.9	32	19	6	3
7E	30	7.3	24	12	9	4
8	34	5.8	12	7	0	2
9	24	8.0	24	12	3	3
10	35	6.0	12	5	5	0
11	30	8.2	23	14	4	7
12	42	6.0	12	19	8	5
13	24	8.2	26	11	7	4
14	25	6.0	12	20	7	6
15	30	8.5	36	24	6	5
16	30	6.1	12	16	7	3
17	29	5.8	12	15	5	7
18	29	5.8	12	16	8	6
19	36	5.7	12	12	6	3
20	36	6.0	12	11	2	5
21	24	7.8	25	10	3	0
22	24	8.5	23	12	5	4
23	24	7.9	30	10	7	3
24	24	5.8	12	7	0	4
25	30	6.1	12	10	7	3
26	13	6.7	19	7	0	4
27	10	6.2	21	7	4	1
28	30	8.7	24	11	5	4
29	30	8.8	33	10	8	6
31	7	6.2	12	3	2	2
32	8	6.4	13	3	1	0
33	9	5.7	12	1	2	7

TABLE E - 7

RUN NUMBER	NUMBER OF TRACTORS AND TRAILERS	COMPACTION APPARATUS?	QUEUEING AT TRANSFER STATION?	INVESTMENT IN TRANSFER STATION LAND AND STRUCTURES
1	4 & 8	N	Y	$ 278,000.
3	5 & 8	N	Y	299,000.
5	3 & 6	N	Y	278,000.
7A	3 & 7	N	Y	299,000.
7B	3 & 7	N	Y	299,000.
7C	3 & 7	N	Y	299,000.
7D	3 & 8	N	Y	299,000.
7E	3 & 8	N	Y	299,000.
9	3 & 7	N	Y	278,000.
11	4 & 7	N	Y	299,000.
13	2 & 5	N	Y	278,000.
15	3 & 5	N	Y	299,000.
21	2 & 3	Y	Y	428,000.
22	2 & 5	Y	Y	428,000.
23	3 & 5	Y	Y	428,000.
24	3 & 6	N	N	278,000.
25	3 & 8	N	N	299,000.
26	2 & 5	N	Y	175,000.
27	2 & 4	N	Y	299,000.
28	2 & 11	N	Y	299,000.
29	4 & 6	N	Y	299,000.
31	2 & 3	N	Y	165,000.
32	2 & 3	N	Y	165,000.
33	2 & 3	N	Y	165,000.

TABLE E - 8

RUN NUMBER	NUMBER OF TRACTORS	NUMBER OF TRACTORS GETTING THE INDICATED OVERTIME IN THE WEEK			COLLECTION PER WEEK	AUXILLIARY COMPACTION
		1 hr.	2 hr.	2 hr.		
1	4	9	3	1	2	n
3	5	4	3	0	3	n
5	3	5	0	2	2	n
7A	3	5	2	0	3	n
7B	3	5	1	1	3	n
7C	3	3	2	1	3	n
7D	3	5	2	0	3	n
7E	3	8	0	0	3	n
9	3	7	2	0	2	n
11	4	3	1	1	3	n
13	2	3	1	0	2	n
15	3	2	0	1	3	n
21	2	2	0	0	2	y
22	2	1	0	1	2	y
23	3	2	1	1	2	y
24	3	3	2	1	2	n
25	3	6	0	0	3	n
26	2	2	1	1	2	n
27	2	3	0	0	2	n
28	2	6	1	4	3	n
29	4	1	1	2	3	n
31	2	0	1	1	2	n
32	2	0	0	0	2	n
33	2	1	0	2	2	n

TABLE E - 9

NUMBER OF TRIPS DURING WEEK BY

RUN	TRACTOR					TRAILER										
NUMBER	51	52	53	54	55	71	72	73	74	75	76	77	78	79	80	81
1	25	22	22	--	--	15	14	14	14	11	11	8	3	--	--	--
3	21	20	18	16	14	15	15	14	13	12	9	6	5	--	--	--
5	35	26	26	--	--	22	20	18	15	12	2	--	--	--	--	--
7A	36	28	26	--	--	20	19	16	14	12	7	2	--	--	--	--
7B	35	28	27	--	--	[illegible]	19	18	14	11	4	2	--	--	--	--
7C	35	28	26	--	--	20	19	17	14	12	6	1	--	--	--	--
7D	34	27	27	--	--	20	17	14	14	13	7	2	1	--	--	--
7E	35	28	27	--	--	22	18	16	14	12	5	2	1	--	--	--
9	32	32	25	--	--	19	18	16	14	11	9	2	--	--	--	--
11	29	24	19	18	--	19	18	16	14	11	9	3	--	--	--	--
13	47	43	--	--	--	26	22	19	15	8	--	--	--	--	--	--
15	41	31	17	--	--	28	24	20	14	3	--	--	--	--	--	--
21	37	12	--	--	--	20	18	11	--	--	--	--	--	--	--	--
22	27	22	--	--	--	16	14	12	6	1	--	--	--	--	--	--
23	23	16	10	--	--	15	14	11	9	--	--	--	--	--	--	--
24	36	27	26	--	--	21	19	17	14	11	7	--	--	--	--	--
25	34	28	28	--	--	19	19	17	14	11	7	2	1	--	--	--
26	27	22	--	--	--	15	13	12	8	1	--	--	--	--	--	--
27	26	15	--	--	--	16	12	10	3	--	--	--	--	--	--	--
28	46	13	--	--	--	19	16	15	13	7	6	6	2	2	2	1
29	33	25	18	14	--	24	21	16	14	10	5	--	--	--	--	--
31	20	4	--	--	--	11	9	4	--	--	--	--	--	--	--	--
32	22	10	--	--	--	13	11	8	--	--	--	--	--	--	--	--
33	33	9	--	--	--	13	12	7	--	--	--	--	--	--	--	--

TABLE E - 10

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VOLUME II

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PART 1: USER'S GUIDE TO THE SIMULATION MODEL

USER'S GUIDE TC THE JOHNS HOPKINS
SOLID WASTE COLLECTION SIMULATION MODEL

The report resulting from the preparation of the simulation model is composed of two volumes. It is recommended that both be available to the prospective user. The user of these programs can realize the full intended simulation potential by adjusting the values of model data and policy variables, which are grouped in two locations in the program. These locations are:

(1) The next to the last card in the entire program upon which are punched nine variable values, e.g., collection frequency, which control system policies to a large extent. This card is termed the System Control Card. (RUNDAT discussion, pages 93-95, Vol. 1)

(2) The BLOK DATA subprogram, in which the user puts the great mass of physical characteristics of entities in the model, the field characteristics of the simulated system, and the costs to be associated with different activities. Examples are the collection truck capacity for the first, the distribution of truck dumping time for the second, and daily pay of a driver for the last. (BLOK DATA discussion, pages 33-36, Vol. 1)

Both of these control areas, the System Control Card and the BLOK DATA subprogram, are explained in detail in following sections of this Guide.

The five following sections discuss the information which is given to the program:

(1) Major system environmental conditions and policies.

(2) System Control Card.

(3) Geographic information in BLOK DATA subprogram.

(4) Field performance information and costs in BLOK DATA subprogram.

(5) Computer requirements and output.

Section 1

MAJOR SYSTEM ENVIRONMENTAL CONDITIONS AND POLICIES

The extent of the studies of which the model is capable and the investigation which was made of proposed changes in the Baltimore system are discussed in detail in Volume 1 (pages 12, 76-88, 115-116, 139, and 145).

Summarizing these complete discussions, a single run on the computer can simulate a collection system with the following control by the user:

(1) The trucks carry the refuse directly to a disposal site with no transfer station (Model 3A); or, the trucks carry the refuse to a transfer station with an unlimited number of unloading docks and with tractor-trailers for transport of the refuse to a disposal site (Model 3B); or, the trucks carry the refuse to a transfer station with two unloading docks and with tractor-trailers for transport of the refuse to a disposal site (Model 3C).

(2) Collection frequency may be either semiweekly or triweekly.

(3) Truck volumetric capacity may be varied.

(4) Truck minimum loaded weight may be varied.

(5) With reference to the number of household units making up a daily task assignment for a truck, the model equations generate assignments which average about 6.5 hours per day for 20 cubic yard trucks.

(6) Rates of pay and overtime pay to labor may be adjusted.

(7) Location of the disposal site and routes to it may be varied.

(8) Location of the transfer station, if any, and routes to it may be varied.

(9) Trailer volumetric capacity may be varied.

(10) Trailer minimum loaded weight may be varied.

(11) The option exists of auxiliary compaction apparatus at the transfer station.

(12) Equipment hourly charges may be varied.

(13) Permanent installation capital investment and amortization may be varied.

(14) The real urban tract for which the model simulates a collection system may be bounded as desired by the user with a maximum population constraint of approximately 300,000 people.

Section 2

THE SYSTEM CONTROL CARD

The user is again referred to pages 93-95 of Volume 1. Reference is also made to the model coding in the latter part of this volume and the command indexed "0610RUND".

(1) Control variable 1, COLFRE, is the collection frequency, which may be 2 or 3 times per week. The value, 2.0 or 3,0, is punched in columns 3, 4, and 5.*

(2) Control variable 2, ASSSUN, communicates which of the three models, 3A, 3B, or 3C (pages 85-96, Vol. 1) is to be run. The value are: 0.0 for Model 3A, 1.0 for Model 3B, and 2.0 for Model 3C. The value must be punched in columns 8, 9, and 10.

(3) Control variable 3, ASSUNK, adjusts the number of household units assigned as a collection truck's daily task; the normal value is 1.0. The variable appears in the command indexed "0740TB1". If ASSUNK is given a value less than unity, the number of units assigned is decreased and vice versa. A value of 1.2 will increase the average daily assignment by 20%. Thus if a truck smaller than the standard 20 cubic yards capacity is to be in the model or if it is desired to reduce the average work hours of the standard truck, the value would be set less than unity. Likewise, if a truck larger than standard is to be in the model

---

*Unless specified, each variable contains an imbedded decimal point.

or if longer workdays are desired, the value would be set greater than unity. The value is punched in columns 11 to 15, right justified.*

(4) Control variable 4, TRLHAL, and control variable 9, Q10. If a transfer station is in the simulated system, Q10 is given the value of 1.0 and TRLHAL is the one-way traffic distance in miles between the transfer station and the disposal site, having values such as 5.0, 18.3, or 27.9.

If no transfer station is in the simulated system, Q10 is normally given the value of 0.0 and TRLHAL is the average one-way distance in miles between the disposal site and the population centroid of the urban tract under study. However, a refinement in model usage is possible in this latter case. If Q10 is given a value of 1.0 and TRLHAL set at 0.0, the model calculates collection trucks' traffic distances from each of many subareas in the urban tract. Section 3 of this Guide discusses this latter use in detail.

In all cases, the value of TRLHAL is punched in columns 16 to 20, right justified. The value of Q10 is punched in columns 41 to 45, right justified.

(5) Control variable 5, RUNNO, is the User's run number; it is expressed as 2.0, 17.0, etc. Its value is punched in columns 21 to 25, right justified.

---

*right justified: the rightmost digit must be in the rightmost column of the specified field.

(6) Control variable 6, K, is an integer number which controls the values of the pseudorandom numbers which are generated for drawing from frequency distributions of stochastic events. A different sequence of pseudorandom numbers is generated with each different K. The value of integer zero, 0, is satisfactory for all runs; however, the use of different K's for different runs on an identical system will test response sensitivity to randomness. The value of K must be integer, may be between 0 and 99999, inclusive, and should be punched in columns 26 to 30, right justified, without decimal point.

(7) Control variable 7, NOTRC, is meaningless if no transfer station is in the simulated system; it should be given a value of 1 in column 35 in this case. However, if a transfer station is in the model, NOTRC affects the number of long-haul tractors at the transfer station. If NOTRC is set at integer zero, 0, a reasonable number of tractors for assignment is calculated by the model. If, however, the User wants to assign a certain number of tractors, NOTRC is given the desired number between 1 and 10. The value is integer, and is punched in columns 34 and 35, right justified, without decimal point.

(8) Control variable 8, Q9, is the control for paying or not paying overtime to collection truck personnel. No overtime is paid if set equal to 0.0; overtime is paid if set equal to 1.0. The value is punched in columns 38 through 40, right justified.

Section 3

GEOGRAPHIC INFORMATION IN BLOK DATA SUBPROGRAM

The urban tract must first be delineated into "census tracts". These are relatively small, usually of less than 6,000 population, and are established by the Bureau of the Census as basis for compiling census data. The population density in housing units per acre for each tract and the number of housing units within each tract must be tabulated. The former data are translated by the user into one of four neighborhood densities (page 155, Vol. 1).

Having determined the census tracts' boundaries and household density classification in each tract, a map termed the Model Map is prepared. New residential subareas, formed by one or combinations of several adjacent census tracts of the same density classifications, must now be delineated and numbered.

A rectangular grid in units of feet is now superimposed on the Model Map; the grid axis should parallel residential street orientation, if such exists. The grid may be at any convenient point. The disposal site and transfer station site, if any, are plotted or referenced on the map, with their X and Y coordinates (positive or negative) noted.

The population centroid of each residential subarea must be marked and its coordinates noted. This is a matter of user judgement, as many of the subareas will be irregular in shape and may have localized housing interspersed with open areas.

The collection trucks dump either at the disposal site or at the transfer station; in either case, the probable traffic route between each subarea centroid and the truck dumping site is determined by the user.

Four sets of information must be transmitted to the computer in the BLOK DATA subprogram:

(1) Grid coordinates of disposal site and transfer station.
(2) Grid coordinates of subareas' population centroids.
(3) Number of household units in each subarea.
(4) One-way traffic distances for collection trucks.

(1) The grid coordinates of the disposal site are entered as FX and FY in the statement indexed "0650BLK". The grid coordinates of the transfer station are entered as TX and TY in the statement indexed "0750BLK". TX and TY should be given values of 0.0 when Model 3A is run (page 81, Vol. 1).

Assume an urban tract for study is composed of five subareas such that:

Subarea number	Neighborhood classification	No. of households	Centroid X coordinate	Centroid Y coordinate
1	1	9227	53000	64500
2	1	2472	57500	62500
3	3	10303	61500	64500
4	2	861	50800	61500
5	4	6917	52500	62000

TABLE 1

(2) The subareas population centroids are entered in the BLOK DATA subprogram as values of AX1 in "0820BLK" and AY1 in "0860BLK". The values of Table 1 would appear as:

```
     DATA AX1 / 53000., 57500., 61500.,                      0820BLK
1               50800., 52500., 20*0./                       0830BLK
```

and

```
     DATA AY1 / 64500., 62500., 64500.,                      0860BLK
1               61500., 62000., 20*0./                       0870BLK
```

It should be noted that all subarea statements in BLOK DATA have space for data from 25 subareas. Only five subareas exist in this example, thus the 20*0.0 completing the statement.

(3) The number of housing units in each subarea are entered as values of ANOHUN in the statements starting with "0800BLK". Table 1 values would appear as:

```
     DATA ANOHUN / 9227., 2472.,10303.,                      0800BLK
1                   821., 6917., 20*0.0/                     0810BLK
```

(4) The one-way traffic distance for the collection trucks from each subarea centroid to the truck dumping site is communicated to the computer by the commands beginning with "0630TB1", which appear

```
     AHALDS(I) = (ABS(AX1(I) - AX2(I))  +                    0630TB1
                  ABS(AY1(I) - AY2(I))  +
                  ROADIS(I)) / 5280.
```

The choice of each subarea's route may be from three schemes (pages 111 and 112, Vol. 1).

Assume a subarea 1 has a Metric-L route only from its centroid to the dumping site. AX2(1) and AY2(1) are given the values of the dumping site grid coordinates (0840BLK and 0880BLK). ROADIS(1) (1110BLK) is set equal to 0.0.

Assume a subarea 2 has a truck highway direct from its centroid to the dumping site. ROADIS(2) is given the value of the highway distance in feet, and AX2(2) and AY2(2) are set equal to AX1(2) and AY1(2), causing the Metric-L distance in this case to be zero.

Assume a subarea (3) for which the trucks move along a highway to a point "A" and then on a Metric-L path to the subarea centroid. The highway distance in feet from the dumping site to "A" is entered as the value of ROADIS(3). The grid coordinates of "A" are entered for the values of AX2(3) and AY2(3).

The statement for ROADIS information for this example might appear:

```
     DATA ROADIS / 0.0, 9400., 1720., 22*0.0/                1100BLK
```

Section 4

FIELD PERFORMANCE INFORMATION AND COSTS IN BLOK DATA SUBPROGRAM

All variables listed in the BLOK DATA subprogram must be given values for the model to run successfully. In some cases, the value should be or can be zero, but the value must be entered. Reference is made to statement "0610BLK" in BLOK DATA of the model coding in this volume; the three variables, COMPAP, CONA, and CONB are listed together followed by their three values simply as a space saving device. The three statements could have been:

```
          DATA  COMPAP / 150000./              0610BLK
          DATA  CONA   / 40000. /              0612BLK
          DATA  CONB   / 75000. /              0614BLK
```

The latter arrangement would have required three IBM cards rather than the packed one. The variables in the subprogram and the manner in which their values are presented are discussed below:

COMPAP - the capital investment in dollars (including installation) of transfer station auxiliary compaction equipment; this will vary over a wide range depending on the type and manufacturer (pages 110-114, Vol. 1). If compaction equipment is in the model, the variable RIGMAX (0710BLK) must be given the value of the minimum weight of the <u>compacted</u> load to be carried in the trailers.

CONA, CONB, COND, CONE, CONF - these five coefficients appear in several model equations which express transfer station land value and equipment cost as functions of station daily capacity. The equations are indexed "1140TB2" and "1170TB2" for land value; "1090TB2" and "1110TB2" for equipment and structure cost. For the land values, "1170TB2" is applicable for stations with capacity of 200 tons per day or less; "1140TB2" is for stations with daily capacity greater than 200 tons. For costs of station structures and equipment, "1110TB2" is applicable for stations with capacity of 100 tons per day or less; "1090TB2" for greater than 100 tons per day. The user may change the affecting variables, if needed, to fit his simulated system. Auxiliary compaction apparatus cost is not expressed in these coefficients, but with the value of the variable COMPAP.

CSHRTC - the hourly charge for tractor operation in dollars for all costs of the tractor-trailer rig operation except the driver's pay. The value includes fuel, maintenance, and amortization both for the trailers and tractor. The charge is for time of operation of the tractor; no charge is made against the trailers per se. This varies with equipment size.

CSTHR - the hourly charge for collection truck operation in dollars. This charge is for all costs of the collection truck operation except the drivers' and laborers' pay; this includes fuel, maintenance, and amortization. The charge is for actual time of operation. This varies with equipment size.

DELDEP - the model attempts to duplicate the activities at a municipal garage as the trucks leave in the early morning. The trucks normally do not all leave together, but rather depart over a period of time. DELDEP is the increment in minutes between successive collection trucks' departures. The user does not need to change the value, set at 0.1 minute.

DRDPAY - Collection truck's driver's pay in dollars received for a day's work, even if less than eight hours. If over eight hours, the driver receives DRDPAY plus overtime hours times DROVRT.

DROVRT - Collection truck's driver's hourly overtime pay in dollars (see DRDPAY).

FLTLTM - the off-route time in minutes charged to a truck having a flat tire or breakdown. User's option as to changing.

FX, FY - the rectangular grid coordinates in feet of the final disposal site.

IN - the number of input tape for computer installation. This varies with computer installations.

IOU - the number of output tape for computer installation. Varies with computer installations.

KINTRK - the capacity in cubic yards of the compactor collection trucks.

KINTRL - the capacity in cubic yards of the long-haul trailers working out of the transfer station.

NAREA - the number of subareas within the urban tract being investigated. NAREA cannot have a value greater than 25. Each of the subareas is of a homogeneous housing density of one of the four classifications. Varies with different urban tracts under study.

ONCE - the tractor-trailer rigs have a histogram for dumping times at the final disposal site. It is a normal distribution with a mean of ONCE minutes and a standard deviation of TRES minutes. This may vary with the equipment type, but the results are probably not over sensitive to the values.

OVPAYL - the overtime pay in dollars per hour for the collection trucks' laborers.

PAYLBR - the pay in dollars per day for the collection trucks' laborers.

Q5 - Overtime pay in dollars per hour for the driver of the trailer-tractor rig.

Q6 - pay in dollars per day for the driver of the trailer-tractor rigs even if less than an eight hour day.

Q7 - the tax revenue from the transfer station land which is lost to the city because of the city's occupancy rather than commercial or industrial occupancy; expressed in dollars per year.

Q8 - the trailers at the transfer station do not start getting filled in the early morning until the collection trucks have had time to make a trip out and back. The model therefore has the tractor-trailer rig drivers report for duty later than the collection truck personnel. This time lag in minutes is Q8; the one hour value presently in BLOK DATA is probably applicable to most cities.

R - the amortization interest rate for transfer station structures and equipment; also the interest rate applied to the transfer station land investment (page 114, Vol. 1).

RGVMAX - maximum speed in mph allowed the trailer-tractor rigs in traffic.

RGVMIN - minimum speed in mph allowed the trailer-tractor rigs in traffic.

RIGKA & RIGKB - the two equation coefficients in the least squares equation, $\log_{10}V = \text{RIGKA} + (\text{RIGKB}*X)$, which relates trip distances with trailer-tractor rig traffic speeds. V is speed in miles per hour and X is one-way traffic distance in miles. After the dependent variable, $\log_{10}V$, is found from the equation, the log of traffic speed is drawn from a log normal distribution which has "$\log_{10}V$" as the mean and VELSGR as the standard deviation. The command "0720RGO" then gives the true traffic speed. If a new regression equation is desired for the User's locality, a discussion with the city traffic engineer may suggest improved equation coefficients. If the User decides to determine his own coefficients, it is recommended that approximately 100 tractor trips with varying trip distances be made. The least-square regression of $\log_{10}$ speed on one-way trip distance can be calculated and these coefficients and standard error of estimate, VELSGR, determined. It should be noted that the equation is applicable only up to a certain maximum distance "RMXDSR"; above this distance, $\log_{10}V$, normally found from the equation, has a constant value, VELMUR. These two variables are given values in "0730BLK and 0760BLK".

RIGMAX - the minimum net weight in pounds which the transfer station trailers carry. Collection trucks dump individually, and when the accumulated weight on the trailer exceeds RIGMAX, the trailer is replaced by an empty one.

RKA & RKB - the two equation coefficients in the least-squares equation, $\log_{10}V = RKA + (RKB*X)$, which relates trip distance and collection trucks' traffic speeds. V is speed in miles per hour and X is one-way traffic distance in miles. After the dependent variable, $\log_{10}V$, is found from this equation, the log of the traffic speed is drawn from a log normal distribution which has "$\log_{10}V$" as its mean and VELSGT as its standard deviation. The command "0680TRF" then gives the true traffic speed. As discussed with RIGKA and RIGKB, the city traffic engineer may suggest improved equation coefficients and standard deviations. New data can be gathered and a new equation derived if desired. Again this equation is applicable only to a certain maximum distance, "RMXDST"; above this distance, $\log_{10}V$ has a constant value, VELMUT. These two variables are given values in "0730BLK and 0760BLK".

RMXDSR - see discussion on RIGKA

RMXDST - see discussion on RKA

STMFST - the collection trucks are assigned various amounts of minimum off-route time which includes delays in leaving the city garage in the morning, lunch time, and coffee breaks. These off-route times increase from "STMFST" minutes for the first truck to leave the garage in the morning by increments of DELDEP minutes for each succeeding truck (page 29, Vol. 1)

TRES - see discussion on ONCE

TSLBPA - Collection truck laborer's daily pay in dollars.

TX & TY - grid coordinates in feet for the transfer station.

UTILITY - average monthly utility cost of transfer station in dollars; includes water, gas, and electricity.

VELMAX - maximum average speed in mph allowed the collection trucks in traffic.

VELMUR - see discussion on RIGKA

VELMUT - see discussion on RKA

VELMIN - minimum average speed in mph allowed the collection trucks in traffic.

VELSGR - see discussion on RIGKA

VELSGT - see discussion on RKA

WATEZ - the net weight to which the collection trucks are loaded before quitting collection and going to dump. This is a function of the cubic yardage of the truck and the density to which it packs. The 8700 pounds used in Volume 1 came from 20 cubic yard capacity being loaded to 435 pounds per cubic yard (0770BLK). Varies with truck capacity and type.

YRS - amortization term in years for transfer station structures and equipment (page 114, Vol. 1).

ANETYP - This is a subscripted variable for which 25 values are possible of the neighborhood type of each of the urban tract subareas. The example of Table 1 has only 5 subareas, so the statement giving the values for column 2 of this table would appear:

```
DATA ANETYP / 1., 1., 3., 2., 4., 20*0.0 /              0800BLK
```

AX1, AX2, AY1, AY2 - These variables have been discussed in Section 3. The statements "0820BLK to 0890BLK" in the coding were derived from Table 6-1 (pages 118-121, Vol. 1) and show the transmittal of the data from the planner to the computer for the Baltimore tract.

COLMLK - the average street footage per net acre for each of the four neighborhood classifications. This varies greatly between cities. The data statement for Baltimore in the coding reads:

```
DATA COLMLK / 550., 750., 875., 1000., /             0900BLK
```

This means COLMLK for neighborhood density classification 1 = 550 linear feet per net acre, COLMLK(2) = 750 linear feet per net acre, etc.

CORACR - ratio of gross acres to net acres for each of the four neighborhood classifications. This varies greatly between cities and even within cities.

DAYS - This statement (0920BLK) should be left alone; it has computer use in printing the proper values of days, such as MWF or TTS, in the truck assignments of Table 2 of the model results (page 79, Vol. 1).

NOTE:

The statements from 0930BLK to 1090BLK inclusive give values for many frequency distributions (histograms) of field performance information and area data. A discussion follows:

Assume collection trucks' incinerator dumping times in minutes have been observed. The information is:

Time at incinerator in minutes	Number of trucks	% of trucks
2-4	4	16
4-6	5	20
6-8	12	48
8-10	2	8
10-12	1	4
12-14	1	4
	25	100

It is desired to put this table in proper form in the BLOK DATA subprogram so that the simulation of the system also will have 16% of its trucks taking 2 to 4 minutes, 20% taking 4 to 6 minutes, etc. The statement which would transmit this information to the model would appear:

```
DATA HISTD1 / 6., 2., 14., 16., 20., 48., 8., 4., 4., 7*0.0 /   1050BLK
```

The 6. is the number of time increments in data. The 2. is the minimum value in the time range. The 14. is the maximum value in the time range. The 16., 20., 48., 8., 4., 4., are the percentage values of each of the time increments. The 7*0.0 is needed to complete 16 bits of data as the model programming requires it (0510BLK). The HISTK1 is the title for this histogram. The 17 sets of data for model histograms are similarly prepared.

HISC12 through HISC44, (HISC"IJ") are collection rates in pounds of refuse per hour by crews working in neighborhood type "I" with "J" data since last collection. It is noted that some are alike (0970BLK and 0980BLK). This is because no significant difference was indicated between the two conditions. If the user gathers any field information for his study, these 12 sets of data should have high priority as the model results are sensitive to their values. Figures A-14 through A-18 (pages 174-176) are plots of the distributions for these data.

HISTD1 - the histogram of collection trucks' dumping times in minutes (Figure A-20, pages 182 and 183). This information is easy to gather; the user should prepare his own.

HISTU1 through HISTU4 - distributions of housing units per net acre for the four neighborhood classes. This will vary between cities and should be prepared for each urban tract (Figures A-1 through A-4, pages 155-156).

PERUN - the average number of persons per housing unit for the four neighborhood types. This must be given four values as BLOK DATA is so programmed (0530BLK). If the user wants to use the same figure for all neighborhood types, it must be repeated four times, i.e.,

```
DATA PERUN / 3.0, 3.0, 3.0, 3.0 /                    1100BLK
```

ROADIS - this has been discussed in Section 3.

RKKA, RKBB, and RKCC - equation coefficients for the generation of the number of households for a truck's daily assignment (0730TB1). These will not be normally changed by the user.

Section 5

COMPUTER REQUIREMENTS AND OUTPUT

The simulation model has been coded using FORTRAN IV. The runs made at Johns Hopkins University were compiled and executed under an IBSYS monitor on an IBM 7094 computer. The installation consists of an IBM 1401 RAMAC system (used as a slave to the 7094), a 7094 equipped with two data channels with eight tape drives per channel, a printer, and a card reader. The Model should run equally well on any electronic data processing system having a FORTRAN IV compiler, an input/output device and at least 20,000 words or equivalent of core storage.

An average run with a transfer station in the model required the following times.

Compiler	2.55
Assembler	0.43
Loader	0.49
Execution	0.30
Utility	0.11
Total time	3.90 minutes

Approximately 8350 lines output and 250 pages are generated when MAP instructions are included. Models without a transfer station produce about 90% of the above.

The "state of the simulated system" is not reported in time increments as it occurs. The results which are printed (pages 77-84, Vol. 1) are summaries of the six-day week simulated activities and costs.

The user submits the model deck of IBM cards to his computer along with necessary lead cards which identify him, the account to which the run is to be charged, and special instructions. After the run is completed, he will normally get back the deck which he submitted, another deck in machine language, a listing of the model identical to that in this volume, and approximately nine pages of results of his run.

PART 2

FORTRAN IV CODING OF THE SIMULATION MODEL

```
C                 THIS PACKAGE OF FORTRAN IV ROUTINES CAN BE USED TO          MAIN
C       SIMULATE SOLID WASTE COLLECTION FOR A CITY ... TRUITT, 1968          MAIN
C                                                                             MAIN
C          THE FOLLOWING ARE VARIABLES USED IN MODEL THREE                    MAIN
C       AN   DAILY COST OF TS,UTILITIES,AMORTIZATION,ETC                      MAIN
C       ASSUM   A CONTROL VARIABLE, WHEN = 0, NO TRANSFER STATION.            MAIN
C         WHEN  1.,TS + NO QUEUE, WHEN - 2., TS + 2 QUEUES.                   MAIN
C       AASSUM(NA) - NUMBER OF UNITS/TRUCK BY REGRESSION EQUATION            MAIN
C       ACRE - GROSS ACRES                                                    MAIN
C       AHAUDS(NA)   HAUL DISTANCE FROM AREA NA                               MAIN
C       ANETYP(NA) - NEIGHBORHOOD TYPE OF AREA NA                             MAIN
C       ANHOUS(NA)   NUMBER OF HOUSING UNITS IN AREA NA                       MAIN
C       ANROUT(NA)   NUMBER OF ROUTES   WITHIN    AREA NA                     MAIN
C       ASNUPT(NA) - NUMBER OF UNITS/ASSIGNED TO A TRUCK IN AREA NA           MAIN
C       ASSUMP   A CONSTANT HAVING VALUES SUCK AS 0.75 OR 1.20 WHICH         MAIN
C        - RATIO OF NO.OF UNITS ACTUALLY ASSIGNED TO NO. OF UNITS             MAIN
C           CALCULATED FROM THE REGRESSION EQUATION                           MAIN
C       AX1(NA) - X COORDINATE OF CENTROID OF AREA NA                         MAIN
C       AX2(NA)   X COORDINATE OF FINAL-POINT ON METRIC L HAUL PATH           MAIN
C       AY1(NA)   Y COORDINATE OF CENTROID OF AREA NA                         MAIN
C       AY2(NA) - Y COORDINATE OF FINAL POINT ON METRIC L HAUL PATH           MAIN
C       B - A SUBSCRIPTED VARIABLE USED IN RIGBAK + FNLPRN TO COUNT           MAIN
C         TRACTORS OVERTIME.                                                  MAIN
C       CCL   COST OF COLLECTION TRUCK OPERATION PER DAY                      MAIN
C       CLKTM - CLOCKTIME                                                     MAIN
C       COLFRE - COLLECTION FREQUENCY PER WEEK                                MAIN
C       COLPR - PERCENT OF COLLECTION TRUCKS WORKING TIME SPENT IN            MAIN
C         COLLECTION.                                                         MAIN
C       COLMEK    RATIO OF STREET MILEAGE PER ACRE BY NEIGHBORHOOD TYPES      MAIN
C       COLTMZ - TIME IN MINUTES FOR COLLECTING A SINGLE TRUCK LOAD.          MAIN
C       CMPAP - TOTAL COST INCLUDING INSTALLATION OF AUXILLARY COMPACTING     MAIN
C         EQUIPMENT FOR TRANSFER STATION                                      MAIN
C       CONA-  CONSTANTS                                                      MAIN
C       CONB        APPEARING                                                 MAIN
C       CONC             IN EQUATIONS                                         MAIN
C       COND                FOR                                               MAIN
C       CONE                     TRANSFER STATION                             MAIN
C       CONF-                         AND LAND COSTS                          MAIN
C       CORAGR(NETYP) - RATIO OF GROSS ACRES TO NET ACRES                     MAIN
C       COSCOL  COST OF OPERATING COLLECTION TRUCKS FOR ENTIRE WEEK           MAIN
C       COSLND - VALUE OF TRANSFER STATION LAND                               MAIN
C       CREWTS   NUMBER OF MEN,EXCLUDING DRIVERS, STAFFING TRANSFER STA.      MAIN
C       CRUSZ - NUMBER IN COLLECTION TRUCK CREW INCLUDING DRIVER              MAIN
C       CSHRTC - $/HR FOR TRACTOR TIME IN ACTUAL OPERATION                    MAIN
C       CSTHR - $/HR FOR COLLECTION TRUCKS EXCLUDING LABOR                    MAIN
C       CTS - COST OF TRANSFER STATION + RIG OPERATIONS PER DAY               MAIN
C       DAYS(COLFRE - 1.,NDR)     A MATRIX USED IN WRITING TABLE 2            MAIN
C                                 WHICH APPEARS                               MAIN
C                                                      NDR                    MAIN
C                                                1       2      3             MAIN
C                                 COLFRE-1.  1  MONTHU  TUEFRI WEDSAT          MAIN
C                                            2   MWF     TTS    BLANK          MAIN
C                                                                             MAIN
C       DAYSLC - DAYS SINCE LAST COLLECTION                                   MAIN
C       DELDEP - TIME INTERVAL AT WHICH TRUCKS LEAVE IN MORNING (MINUTES)     MAIN
C       DMTAVE -      AVERAGE, MAXIMUM, MINIMUM, + STND. DEV.                 MAIN
C       DMTMAX -                OF                                            MAIN
C       DMTMIN -          COLLECTION TRUCKS TIME IN MINUTES                   MAIN
C       DMTSIG -                 AT TRANSFER STATION                          MAIN
C       DOLCOL - COST IN DOLLARS/TON FOR COLLECTION TRUCKS OPERATIONS         MAIN
C       DOLRIG- COST IN DOLLARS/TON FOR TRANSFER STATION AND                  MAIN
C                                           TRAILER-TRACTOR OPERATIONS        MAIN
C       DOLTON  COST IN DOLLARS/TON FOR ENTIRE OPERATION                      MAIN
C       DOLTS - TOTAL INVESTMENT IN TRANSFER STATION LAND AND EQUIPMENT.      MAIN
C       DRDPAY - DRIVERS DAILY PAY IN DOLLARS                                 MAIN
C       DRVRT   DRIVERS OVERTIME PAY PER HOUR                                 MAIN
C       DSLC - DAYS SINCE LAST COLLECTION                                     MAIN
C       EW - VARIABLE USED TO SIGNAL DSPSL OF NEW DAY-- =0 FOR NEW DAY        MAIN
C       EVENT - TYPE OF EVENT NEXT TO HAPPEN TO COLLECTION TRUCK              MAIN
C       EVENT 1   TRUCK LEAVES YARD AND ENTERS TRAFFIC                        MAIN
C       EVENT 2 - TRUCK LEAVES TRAFFIC AND STARTS COLLECTION                  MAIN
C       EVENT 3 - TRUCK LEAVES COLLECTION AND ENTERS TRAFFIC                  MAIN
C       EVENT 4 = TRUCK LEAVES TRAFFIC AND ENTER YARD                         MAIN
C       EVENT 5 - TRUCK ENTERS QUE                                            MAIN
C       EVENT 7   TRACTOR TRAILER RIG LEAVES TRANSFER STATION                 MAIN
C       EVENT 8   TRACTOR TRAILER ARRIVES BACK AT TRANSFER 'TATION            MAIN
C       FINDAY - AN INDICATOR USED BETWEEN RIGBAK + DSPSL FOR INDICATING      MAIN
C         THAT A TRAILER IS FULL + IDLE.(FINDAY=99).                          MAIN
C       FLATJO   PROBABILITY OF A BREKDOWN OR FLAT TIRE FOR A SINGLE          MAIN
C         TRAFFIC TRIP FOR COLLECTION TRUCKS.                                 MAIN
C       FX - X COORDINATE OF FINAL DISPOSAL SITE                              MAIN
C       FY - Y COORDINATE OF FINAL DISPOSAL SITE                              MAIN
C       HISC12 - -   - - - - - - - - - - - - - - - - -                        MAIN
C       HISC13 -         HISTOGRAMS FOR DISTRIBUTIONS OF                      MAIN
C       HISC14 -         COLLECTION RATES IN POUNDS PER HOUR.                 MAIN
C       HISC22 -         THE LAST TWO NUMBERS IJ                              MAIN
C       HISC23 -                                                              MAIN
C       HISC24 -                 REFER TO                                     MAIN
C       HISC32 -                                                              MAIN
C       HISC33 -            I = NEIGHBORHOOD TYPE                             MAIN
C       HISC34 -            J = DAYS SINCE LAST COLLECTION                    MAIN
C       HISC42 -                                                              MAIN
C       HISC43 -                                                              MAIN
C       HISC44 - - - - - - - - - - - - - - - - - - - - -                      MAIN
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C     HISTO1 -  HISTOGRAMS FOR THE
C     HISTO2 -       DISTRIBUTIONS OF                                          MAIN
C     HISTO3 -           HOUSING UNITS PER ACRE                                MAIN
C     HISTO4 -               IN THE 4 NEIGHBORHOOD TYPES.                      MAIN
C     HISTD1 - COLLECTION TRUCKS DUMPING TIME HISTOGRAM.  (MINUTES)            MAIN
C     ICOLFR - COLLECTION FREQUENCY PER WEEK                                   MAIN
C     IN  - NUMBER OF INPUT TAPE                                               MAIN
C     IOU - NUMBER OF OUTPUT TAPE                                              MAIN
C     IRUNNO - RUN NUMBER                                                      MAIN
C     ITIME(LD,NO) - LAST CLOCK TIME THAT QUEUE LD HAD (NO-1) TRUCKS           MAIN
C       IN IT.                                                                 MAIN
C     JDW -  INTEGER DAYS OF WEEK, I.E. 1,2,3,ETC.                             MAIN
C     JTRC - INTEGER NUMBER OF EACH TRACTOR                                    MAIN
C     JTRL - INTEGER NUMBER OF EACH TRAILER                                    MAIN
C     JTRPCL - WEEKLY TOTAL OF COLLECTION TRUCKS ROUNDTRIPS                    MAIN
C     JTRPRG - WEEKLY TOTAL OF TRAILER TRACTOR RIGS ROUNDTRIPS                 MAIN
C     K - A CONTROL VARIABLE, WHEN = 0, RANDOM NUMBER SERIES CANNOT BE         MAIN
C       DUPLICATED IN FOLLOWING RUNS. IF = POSITIVE INTEGER, THE SERIES        MAIN
C       IS ALWAYS THE SAME + RUNS CAN BE DUPLICATED EXACTLY.                   MAIN
C     K2 - COUNTER FOR TSTM, TIME SPENT AT TRANSFER STATION                    MAIN
C     K2RIG - A SWITCHING VARIABLE IN DSPSL WHICH INDICATES IF MORE            MAIN
C       THAN ONE EVENT IS GENERATED BY SUBROUTINE.                             MAIN
C     K3TRK - A SWITCHING VARIABLE IN DSPSL WHICH INDICATES IF MORE            MAIN
C       THAN ONE EVENT IS GENERATED BY SUBROUTINE.                             MAIN
C     K4 - A COUNTER FOR QUT2.I.E.  QUT2(K4)                                   MAIN
C     K5 - A VARIABLE SUBSCRIPT, DAYS(K5,J)                                    MAIN
C     KAPTS - CAPACITY IN TONS PER DAY OF TRANSFER STATION                     MAIN
C     KINTRK - CAPACITY OF COLLECTION TRUCKS                                   MAIN
C     KINTRL - CAPACITY OF TRAILERS                                            MAIN
C     KKK - KTMCP - 1                                                          MAIN
C     KSTMES - STMEST*10.0                                                     MAIN
C     L  -  A COUNTER                                                          MAIN
C     MAXLQ - MAXIMUM LENGTH OF TRANSFER STATION QUEUE                         MAIN
C     NA = AREA NUMBER                                                         MAIN
C     NAREA - NUMBER OF AREAS INTO WHICH TRACT IS DIVIDED                      MAIN
C     NC -  COLFRE - 1.                                                        MAIN
C     NCR - NUMBER OF DIFFERENT ROUTES ASSIGNED TO A TRUCK + = 6./COLFRE       MAIN
C     NINQ(I)   NUMBER OF COLLECTION TRUCKS IN QUEUE I.                        MAIN
C     NN - ANETYP(I)                                                           MAIN
C     NOFLTS - NUMBER OF FLATS OR BREAKDOWN                                    MAIN
C     NOROT - NUMBER OF ROUTES INTO WHICH A SUBAREA IS DIVIDED.                MAIN
C     NOTRC - NUMBER OF TRACTORS                                               MAIN
C     NOTRC2 - 50 * NUMBER OF TRACTORS.                                        MAIN
C     NOTRK   NUMBER OF COLLECTION TRUCKS IN MODEL                             MAIN
C     NOTRL - NUMBER OF TRAILERS                                               MAIN
C     NOVRT1   NUMBER OF TRUCKS WHICH LOGGED                                   MAIN
C     NOVRT2 -                1, 2, + OVER 3 HOURS OF OVERTIME                 MAIN
C     NOVRT3 -                                                                 MAIN
C     NT - EVENT NUMBER                                   DURING WEEK          MAIN
C     ONCE - THE MEAN OF THE NORMAL DISTRIBUTION OF TIME SPENT BY              MAIN
C       TRAILER-TRACTOR RIGS AT THE FINAL DISPOSAL SITE. (MINUTES).            MAIN
C     OPTM - OPERATING TIME OF TRACTORS IN MINUTES                             MAIN
C     ORRR - AN ACCUMULATOR OF OFFROUTE TIME FOR ALL COLLECTION TRUCKS         MAIN
C            IN MINUTES                                                        MAIN
C     OVPAYL - LABORERS OVERTIME PAY. (DOLLARS PER HOUR)                       MAIN
C     OVRTM - A SUBSCRIPTED VARIABLE.   OVERTIME FOR COLLECTION TRUCK          MAIN
C       IN HOURS.  OVRTM(NT)                                                   MAIN
C     PAYLBR - LABORERS DAILY PAY                                              MAIN
C     PERUN - A SUBSCRIPTED VARIABLE, AVERAGE NUMBER OF PERSONS LIVING         MAIN
C       IN A HOUSEHOLD UNIT FOR EACH OF THE 4 NEIGHBORHOOD TYPES               MAIN
C     PNDSIG - THE STANDARD DEVIATION OF THE NORMAL DISTRIBUTION OF THE        MAIN
C       POUNDS PER PERSON PER DAY OF GENERATED SOLID WASTE.                    MAIN
C     PRBFLT  - NUMBER OF BREAKDOWNS PER 1000 MILES OF TRAFFIC FOR             MAIN
C       COLLECTION TRUCKS.                                                     MAIN
C     Q5 - OVERTIME PAY PER HOUR FOR TRACTOR DRIVER                            MAIN
C     Q6 - DAILY PAY FOR TRACTOR DRIVERS                                       MAIN
C     Q7 - YEARLY LOST TAX REVENUE FROM TRANSFER STATION LAND                  MAIN
C     Q8 - TIME IN MINUTES AFTER ZERO CLOCK TIME WHEN TRACTOR DRIVERS          MAIN
C       REPORT FOR DUTY.                                                       MAIN
C     Q9 - A RUN CONTROL VARIABLE,WHEN = 0. NO OVERTIME IS PAID TO             MAIN
C       COLLECTION TRUCK CREWS, WHEN = 1. OVERTIME IS PAID.                    MAIN
C     Q10 - A RUN CONTROL VARIABLE, WHEN = 0.,ALL COLLECTION TRUCKS            MAIN
C       ARE CONSIDERED TO HAVE THE SAME TRAFFIC HAUL DISTANCE WHICH IS         MAIN
C       EQUAL TO THE VALUE OF TRLHAL.   WHEN = 1. COLLECTION TRUCKS HAVE       MAIN
C       DIFFERENT HAUL DISTANCES, EACH BEING CALCULATED FROM METRIC L          MAIN
C       PATHS + ROADS.                                                         MAIN
C     QUTAVE -    AVERAGE,                  OF           LENGTH OF COL         MAIN
C     QUTMAX -         MAXIMUM,                          TRUCKS WORKDAY        MAIN
C     QUTMIN -              MINIMUM +                    IN HOURS              MAIN
C     QUTSIG -                   STNG DEVIATION                                MAIN
C     QTIME(I)   - TIME OF EVENT 5 FOR LAST COLLECTION TRUCK AT QUEUE I.       MAIN
C     QTM - TIME IN QUEUE FOR A PARTICULAR TRUCK.                              MAIN
C     QUITMC - QUITTING TIME EACH DAY FOR TRACTORS                             MAIN
C     QTTIM(NT,JDW) - MATRIX OF QUITTING CLOCK TIME OF TRUCKS,NT, ON           MAIN
C       DAY OF THE WEEK, JDW.  (MINUTES)                                       MAIN
C     QUT2 - A SUBSCRIPTED VARIABLE WHICH IS A VECTOR OF QUITTING              MAIN
C       TIMES FOR COLLECTION TRUCKS FOR ENTIRE WEEK. K4 IS ITS COUNTER.        MAIN
C     R - AMORTIZATION INTEREST RATE FOR TRANSFER STATION AND LAND             MAIN
C     RDPTM - TRAILER-TRACTOR RIG TIME AT FINAL DISPOSAL SITE GENERATED        MAIN
C       FROM A NORMAL DISTRIBUTION. (MINUTES)                                  MAIN
C     RGVMAX - THE UPPER LIMIT IN MPH FOR TRACTOR-TRAILER SPEEDS.              MAIN
C     RGVMIN - THE LOWER LIMIT IN MPH FOR TRACTOR-TRAILER SPEEDS.              MAIN
C     RIGRA  - Y INTERSECT IN REGRESSION EQUATION OF LOG SPEEDS OF             MAIN
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C       TRAILER TRACTORS ON DISTANCE.                                   MAIN
C     RIGRB - COEFFICIENT OF INDEPENDENT VARIABLE, DISTANCE, IN         MAIN
C       REGRESSION EQUATION OF LOG SPEEDS OF TRAILER TRACTORS ON        MAIN
C       DISTANCE.                                                       MAIN
C     RIGMAX  NET WEIGHT PAY LOAD OF LONG HAUL TRAILER.                 MAIN
C     RIGVEL   TRACTOR TRAILER SPEED MPH                                MAIN
C     RKA   Y INTERSECT IN REGRESSION EQUATION OF LOG SPEEDS OF         MAIN
C       COLLECTION TRUCKS ON DISTANCE.                                  MAIN
C     RKB   COEFFICIENT OF INDEPENDENT VARIABLE, DISTANCE, IN REGRESSION MAIN
C       EQUATION OF LOG SPEEDS OF COLLECTION TRUCKS ON DISTANCE.        MAIN
C     RKAA    COEFFICIENTS IN REGRESSION EQUATION                       MAIN
C     RKBB                  OF NUMBER OF UNITS ASSIGNED TO A TRUCK      MAIN
C     RKCC                         ON HAUL DISTANCE + NEIGHBORHOOD TYPE MAIN
C     RMXDST   THE UPPER LIMIT OF THE INDEPENDENT VARIABLE, DISTANCE,   MAIN
C       FOR WHICH THE REGRESSION OF LOG SPEEDS OF COLLECTION TRUCKS ON  MAIN
C       DISTANCE IS APPLICABLE.                                         MAIN
C     RMXGSR - THE UPPER LIMIT OF THE INDEPENDENT VARIABLE, DISTANCE,   MAIN
C       FOR WHICH THE REGRESSION OF LOG SPEEDS OF TRACTOR-TRAILER RIGS  MAIN
C       ON DISTANCE IS APPLICABLE.                                      MAIN
C     RNI - A RANDOM NUMBER                                             MAIN
C     RUNNO   THE RUN NUMBER                                            MAIN
C     SCOLMI   SUM OF WEEKS COLLECTION MILEAGE FOR COLLECTION TRUCKS    MAIN
C     SHWRKT   TOTAL OPERATING HOURS OF TRANSFER STATION DURING WEEK    MAIN
C     SRIGMI   SUM OF WEEKS MILEAGE FOR TRACTOR-TRAILER RIGS            MAIN
C     STAT - STATUS,IN TRAFFIC,WAITING,ETC.,OF TRAILERS OR TRACTORS     MAIN
C     STATUS = 0   QUE IS EMPTY                                         MAIN
C     STATUS = 1   QUE IS NOT EMPTY                                     MAIN
C     STATUS   8   TRACTOR IS IDLE                                      MAIN
C     STATUS = 9   TRACTOR IS IN TRAFFIC                                MAIN
C     STATUS = 10  TRAILER IS IDLE AND EMPTY                            MAIN
C     STATUS = 11  TRAILER IS IN TRAFFIC                                MAIN
C     STATUS   12  TRAILER IS IDLE AND FULL                             MAIN
C     STATUS = 13  TRAILER IS BEING FILLED                              MAIN
C     STRFMI   SUM OF WEEKS TRAFFIC MILEAGE FOR COLLECTION TRUCKS       MAIN
C     STWFST   STARTING TIME FOR FIRST TRUCK OUT IN MORNING + TIME FOR  MAIN
C                LUNCH PLUS COFFEE BREAKS DURING DAY(MINUTES)           MAIN
C     SUMROT   TOTAL NUMBER OF COLLECTION ROUTES IN MODEL               MAIN
C     TAREA(NT,NDA) - AREA TO WHICH TRUCK NT IS ASSIGNED ON DAY DNA     MAIN
C     THALDS(NT,NDA) - HAUL DISTANCE FOR TRUCK NT ON DAY DNA            MAIN
C     TIME - TIME IN MINUTES AT WHICH NEXT EVENT HAPPENS                MAIN
C     TIMEQ(I,J) - AN ACCUMULATOR MATRIX SHOWING TOTAL TIME WHICH       MAIN
C       QUEUE I HAS HAD J TRUCKS WITHIN IT.                             MAIN
C     TNETYP(NT,NDA) - NETYP OF COLLECTION FOR TRUCK NT ON DAY DNA      MAIN
C     TNUNIT(NT,NDA)   NO. OF UNITS TO COLLECT FOR TRUCK NT ON DAY DNA  MAIN
C     TONAGE - WEIGHT IN TONS BY DAYS                                   MAIN
C     TOTE(JTRC,JDW) - AN ACCUMULATOR OF OVERTIME HOURS OF TRACTOR,JTRC,MAIN
C      ON DAY OF THE WEEK, JDW.                                         MAIN
C     TOTCOS - TOTAL COST FOR WEEKS ACTIVITY                            MAIN
C     TOTTON - TOTAL TONNAGE COLLECTED IN WEEK                          MAIN
C     TRC - A SUBSCRIPTED VARIABLE, TRACTOR NUMBER ASSOCIATED WITH THE  MAIN
C       EVENT NUMBER.                                                   MAIN
C     TRCSTN  - AN ACCUMULATOR WHICH COUNTS THE NUMBER OF COLLECTION    MAIN
C       TRUCK FLAT TIRES OR BREAKDOWNS THROUGH THE WEEK                 MAIN
C     TRES - THE STANDARD DEVIATION OF THE NORMAL DISTRIBUTION OF       MAIN
C       TRAILER-TRACTOR TIME AT THE FINAL DISPOSAL SITE.                MAIN
C     TRFOR   AN ACCUMULATOR OF TRAFFIC TIME FOR ALL COLLECTION TRUCKS  MAIN
C       IN MINUTES.                                                     MAIN
C     TRFTMZ - TIME FOR ONE-WAY COLLECTION TRUCK TRAFFIC TRIP. (MINUTES)MAIN
C     TRIP - A SUBSCRIPTED ACCUMULATOR WHICH COUNTS NUMBER OF ROUND     MAIN
C       TRIPS FOR TRUCKS + TRACTORS.                                    MAIN
C     TRKDAY   NUMBER OF ROUTES * NUMBER OF COLLECTIONS PER WEEK        MAIN
C     TRKLD(NT) - WEIGHT CARRIED BY TRUCK TO DISPOSAL  POINT            MAIN
C     TRL - A SUBSCRIPTED VARIABLE, TRAILER NUMBER ASSOCIATED WITH THE  MAIN
C       EVENT NUMBER.                                                   MAIN
C     TRLHAL - DISTANCE IN MILES FROM TRANSFER STATION TO FINAL DISPOSALMAIN
C     TRPCOL - NUMBER OF TRIPS BY COLLECTION TRUCKS DURING WEEK         MAIN
C     TRPRIG - NUMBER OF TRIPS BY TRACTOR-TRAILER RIGS DURING WEEK      MAIN
C     TRPTM - MINUTES FOR TRACTOR TRAILER ROUND TRIP                    MAIN
C     TS - TRANSFER STATION                                             MAIN
C     TSCOST   TOTAL COST IN DOLLARS FOR TRANSFER STATION +             MAIN
C     TSPR   PERCENT OF TIME TRUCKS SPEND AT TRANSFER STATION           MAIN
C     TSLBPA   DAILY PAY FOR TRANSFER STATION LABORER (DOLLARS)         MAIN
C     TSTM - MINUTES WHICH COLLECTION TRUCK IS AT TS                    MAIN
C     TX - X COORDINATE OF TRANSFER STATION                             MAIN
C     TY   Y COORDINATE OF TRANSFER STATION                             MAIN
C     UNACRE - NUMBER OF HOUSING UNITS PER NET ACRE                     MAIN
C     UTILTY   MONTHLY UTILITY(WATER,ELECTRICITY,ETC.) COST OF TRANSFER MAIN
C       STATION.                                                        MAIN
C     VELMAX - UPPER LIMIT OF COLLECTION TRUCK TRAFFIC SPEED. (MPH)     MAIN
C     VELMIN   LOWER LIMIT OF COLLECTION TRUCK TRAFFIC SPEED. (MPH)     MAIN
C     VELMOR - MEAN OF NORMAL DISTRIBUTION OF LOG SPEEDS FOR DISTANCES  MAIN
C       GREATER THAN RMXGSR.                                            MAIN
C     VELMUT - MEAN OF NORMAL DISTRIBUTION OF LOG SPEEDS FOR DISTANCES  MAIN
C       GREATER THAN RMXDST.                                            MAIN
C     VELSGR - STANDARD ERROR OF ESTIMATE OF REGRESSION OF LOG SPEEDS   MAIN
C       OF TRAILER-TRACTOR ON DISTANCE.                                 MAIN
C     VELSET - STANDARD ERROR OF ESTIMATE OF REGRESSION OF LOG SPEEDS   MAIN
C       OF TRUCK ON DISTANCE.                                           MAIN
C     WAT(NT) - WEIGHT IN POUNDS TO BE COLLECTED IN DAY BY TRUCK NT     MAIN
C     WATEZ - NET WEIGHT PAY LOAD OF COLLECTION TRUCKS                  MAIN
C     WT - AN ACCUMULATOR OF WEIGHT COLLECTED EACH DAY. (POUNDS)        MAIN
C     X11 - ANCRO(I,J),A VARIABLE USED TO CONSERVE SPACE                MAIN
C     XDAY - NUMBER OF COLLECTION TRUCKS IN USE FOR FIRST COLLECTION    MAIN
C       ROUTE OF THE WEEK, THERE MAY BE FEWER ON LATER ROUTES.          MAIN
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C      YRS    - NUMBER OF YEARS FOR AMORTIZATION OF TRANSFER STATION          MAIN
C         STRUCTURES & EQUIPMENT CAPITAL INVESTMENT.                          MAIN
C                                                                             MAIN
C      COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                  0010MAIN
C                                                                         0020MAIN
       COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2        0030MAIN
       COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK       0040MAIN
       COMMON MAXCRE,MAXINT,MAXI,ITYPE1                                   0050MAIN
       DIMENSION ICORE(1000), CORE(50)                                    0060MAIN
       EQUIVALENCE(ICORE,CORE)                                            0070MAIN
C                                                                         0080MAIN
C                                                                         0090MAIN
C      COMMON AND DIMENSION FOR SIMULATION                                0100MAIN
C                                                                         0110MAIN
       COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,            0120MAIN
      1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0130MAIN
      2             COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0140MAIN
      3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSEND,             0150MAIN
      4             CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0160MAIN
      5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0170MAIN
      6             DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0180MAIN
      7             FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,             0190MAIN
      8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0200MAIN
      9             HISC42,HISC43,HISC44                                  0210MAIN
       COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                    0220MAIN
      1             ICOLER,IN,INCRMT,IOU,IRUNNO,ITIME,JDW,JTRC,           0230MAIN
      2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0240MAIN
      3             KINTRL,KSTMES,KTMDP,MAXLQ,NA,NAREA,NC,NDA,            0250MAIN
      4             NCR,NN,NORUT,NOELTS,NOTRC,NOTRC2,NOTRK,               0260MAIN
      5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0270MAIN
      6             ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNOMU,PNOSIG,          0280MAIN
      7             PRBELT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0290MAIN
      8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0300MAIN
      9             QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0310MAIN
       COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,            0320MAIN
      1             ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0330MAIN
      2             SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,              0340MAIN
      3             TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0350MAIN
      4             TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0360MAIN
      5             TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,             0370MAIN
      6             TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0380MAIN
      7             TSLHPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0390MAIN
      8             VELMIN,VELMOR,VELMOT,VELSGR,VELSGT,WATE,              0400MAIN
      9             WATEZ,WT,XDAY,YRS                                     0410MAIN
       DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),            0420MAIN
      1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,          0430MAIN
      2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,           0440MAIN
      3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),           0450MAIN
      4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),            0460MAIN
      5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),            0470MAIN
      6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),            0480MAIN
      7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),            0490MAIN
      8           OPTM(60)   ,OVRTM(50) ,PERUN(4)  ,QQ(50)     ,          0500MAIN
      9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)               0510MAIN
       DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0520MAIN
      1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,            0530MAIN
      2           DAYS(2,3), ITIME(2,12), QUITTM(50,6), RKAA(4,2),        0540MAIN
      3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),         0550MAIN
      4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                 0560MAIN
C                                                                         0570MAIN
C              --- START OF SIMULATION ---                                0580MAIN
C                                                                         0590MAIN
       CALL DRIVER                                                        0600MAIN
       STOP                                                               0610MAIN
       END                                                                0620MAIN


$IBFTC BLOK.                                                              0010 BLK
       BLOCK DATA                                                         0020 BLK
C                                                                         0030 BLK
C      COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                  0040 BLK
C                                                                         0050 BLK
       COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2        0060 BLK
       COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK       0070 BLK
       COMMON MAXCRE,MAXINT,MAXI,ITYPE1                                   0080 BLK
       DIMENSION ICORE(1000), CORE(50)                                    0090 BLK
       EQUIVALENCE(ICORE,CORE)                                            0100 BLK
C                                                                         0110 BLK
C                                                                         0120 BLK
C      COMMON AND DIMENSION FOR SIMULATION                                0130 BLK
C                                                                         0140 BLK
       COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,            0150 BLK
      1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0160 BLK
      2             COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0170 BLK
      3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSEND,             0180 BLK
      4             CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0190 BLK
      5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0200 BLK
      6             DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0210 BLK
      7             FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,             0220 BLK
      8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0230 BLK
      9             HISC42,HISC43,HISC44                                  0240 BLK
       COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                    0250 BLK
      1             ICOLER,IN,INCRMT,IOU,IRUNNO,ITIME,JDW,JTRC,           0260 BLK
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     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPIS,KINTRK,                0270 BLK
     3            KINTRL,KSTMES,KTPOP,MAXLG,NA,NAREA,NC,NDA,                 0280 BLK
     4            NOR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,                    0290 BLK
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,                   0300 BLK
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,               0310 BLK
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,                  0320 BLK
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,                   0330 BLK
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA                   0340 BLK
      COMMON /B0/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,                0350 BLK
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,              0360 BLK
     2            SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,                   0370 BLK
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                     0380 BLK
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,                0390 BLK
     5            TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,                  0400 BLK
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                    0410 BLK
     7            TSLHPA,TSIM,TX,TY,UNACRE,UTILTY,VELMAX,                    0420 BLK
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,                   0430 BLK
     9            WATEZ,WT,XDAY,YRS                                          0440 BLK
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),                0450 BLK
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,                0460 BLK
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,                0470 BLK
     3           CORACR(4) ,CTS(6)    ,EVENT(60) ,HISC12(16),                0480 BLK
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),                0490 BLK
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),                0500 BLK
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),                0510 BLK
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),                0520 BLK
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,                0530 BLK
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)                   0540 BLK
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) ,  0550 BLK
     1           TRKLD(50) ,TRL(60)   ,TSIM(1000),WATE(50) ,                 0560 BLK
     2           DAYS(2,3), ITIME(2,12), QUITTM(50,6), RKAA(4,2),            0570 BLK
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),             0580 BLK
     4           TIMEQ(2,12), INETYP(50,3), TNOHUN(50,3)                     0590 BLK
C                                                                            0600 BLK
      DATA COMPAP,CONA,CONB /0.0, 40000.,75000./
      DATA CONC,COND,CONE        / 80000., 125000., 500. /               0620 BLK
      DATA CONF,CSHRTC,CSTHR     / 200., 11., 4.40 /                     0630 BLK
      DATA DELCFP,DROPAY,DROVRT / 0.1, 19.80, 3.67 /                     0640 BLK
      DATA FLTLTM,FX,FY          / 45., -39600.,39000. /                 0650 BLK
      DATA IN,IOU,KINTRK,KINTRL / 5,6,20,75 /                            0660 BLK
      DATA NAREA,ONCE,OVPAYL     / 13,11.,3.37 /                         0670 BLK
      DATA PAYLBR,PNDMU,PNDSIG   / 18.,1.95,0.09 /                       0680 BLK
      DATA PRBFLT,Q5,Q6          / 0.001,3.75,20. /                      0690 BLK
      DATA Q7,Q8,R               / 0.0,60.,0.10 /                        0700 BLK
      DATA RGVMAX,RGVMIN,RIGKA   / 45.,20.,0.978 /                       0710 BLK
      DATA RIGKB,RIGMAX,RKA      / 0.0419,30000.,0.978 /                 0720 BLK
      DATA RKB,RMXDSR,RMXDST     / 0.0419,15.,15. /                      0730 BLK
      DATA STMFST,TRES,TSLHPA    / 50.1,3.,20. /                         0740 BLK
      DATA TX,TY,UTILTY,VELMAX   / 66000.,39000.,100.,40. /              0750 BLK
      DATA VELMUR,VELMUT,VELMIN / 1.605,1.605,10. /                      0760 BLK
      DATA VELSGR,VELSGT,WATEZ   / 0.1366,0.1366,8700. /                 0770 BLK
      DATA YRS                   / 30./                                  0780 BLK
      DATA ANETYP/ 1.,2.,1.,2.,3.,2.,1.,2.,3.,4.,4.,3.,3.,12*0./         0790 BLK
      DATA ANOHUN/ 5711.,1099.,6124.,2079.,11186.,9659.,7299.,1887.,     0800 BLK
     1             5906.,10519.,6731.,2317.,3937.,12*0./                 0810 BLK
      DATA AX1/ 53100.,54200.,56400.,62300.,63200.,59500.,29300.,82600.,0820 BLK
     1          81500.,83000.,71600.,66600.,62100.,12*0./                0830 BLK
      DATA AX2/ 66000.,54200.,56400.,66000.,63200.,66000.,29300.,82600.,0840 BLK
     1          81500.,83000.,66400.,66000.,66400.,12*0./                0850 BLK
      DATA AY1/ 34600.,41800.,45600.,42200.,38500.,32900.,42900.,38700.,0860 BLK
     1          35500.,31100.,28600.,28300.,28000.,12*0./                0870 BLK
      DATA AY2/ 39000.,41800.,45600.,39000.,38500.,39000.,42900.,38700.,0880 BLK
     1          35500.,31100.,30600.,28300.,30600.,12*0./                0890 BLK
      DATA COLMLK/ 550.,750.,875.,1000. /                                0900 BLK
      DATA CORACR/ 1.3,1.4,1.6,1.9 /                                     0910 BLK
      DATA DAYS / 6HMONTHU,6H MWF  ,6HTUEFRI,6H TTS  ,6HWEDSAT,6H      /0920 BLK
      DATA HISC12 / 5.,1000.,6000.,22.,36.,22.,10.,10.,8*0. /            0930 BLK
      DATA HISC13 / 5.,1000.,6000.,10.,22.,36.,22.,10.,8*0. /            0940 BLK
      DATA HISC14 / 10.,1000.,11000.,10.,8.,16.,4*12.,3*6.,3*0. /        0950 BLK
      DATA HISC22 / 8.,2000.,10000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  0960 BLK
      DATA HISC23 / 8.,3000.,11000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  0970 BLK
      DATA HISC24 / 8.,3000.,11000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  0980 BLK
      DATA HISC32 / 8.,2000.,10000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  0990 BLK
      DATA HISC33 / 8.,3000.,11000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  1000 BLK
      DATA HISC34 / 8.,3000.,11000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  1010 BLK
      DATA HISC42 / 8.,2000.,10000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  1020 BLK
      DATA HISC43 / 8.,3000.,11000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  1030 BLK
      DATA HISC44 / 8.,3000.,11000.,8.,23.,24.,21.,12.,6.,4.,2.,5*0. /  1040 BLK
      DATA HISTD1 / 10.,2.,12.,8.,10.,26.,20.,8.,4.,4.,12.,6.,2.,3*0. / 1050 BLK
      DATA HISTU1 / 4.,2.,10.,14.,20.,46.,20.,9*0. /                     1060 BLK
      DATA HISTU2 / 5.,10.,20.,5*20.,8*0. /                              1070 BLK
      DATA HISTU3 / 4.,20.,40.,42.,2*23.,12.,9*0. /                      1080 BLK
      DATA HISTU4 / 4.,40.,80.,50.,41.,5.,4.,9*0. /                      1090 BLK
      DATA PERUN  / 2.7,2.9,3.1,3.4 /                                    1100 BLK
      DATA ROADIS / 0.,11900.,12400.,0.,2600.,0.,8300.,12500.,8900.,     1110 BLK
     1              16100.,10200.,13100.,10200.,12*0./                   1120 BLK
      DATA RKAA   / 1155.,1393.,1264.,1129.,1224.,1878.,1703.,1555. /    1130 BLK
      DATA RKBB   / -39.3,-53.0,-49.1,-41.6,-36.8,-77.9,-68.3,-64.4 /    1140 BLK
      DATA RKCC   / .759 ,.976 ,1.015,.874 ,.715 ,1.601,1.447,1.429 /    1150 BLK
C                                                                        1160 BLK
      END                                                                1170 BLK
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$IBFTC BNOR*
      SUBROUTINE BINORM(X,Y,RHO)                                        0010 BNO
      C=.5*(1.+SQRT(1.-RHO*RHO))                                        0020 BNO
      A=SQRT(C)                                                         0030 BNO
      B=SIGN(SQRT(1.-C),RHO)                                            0040 BNO
      S=6.2832*RNNR(0)                                                  0050 BNO
      T=SQRT(-2.*ALOG(RNNR(0)))                                         0060 BNO
      U=T*SIN(S)                                                        0070 BNO
      V=T*COS(S)                                                        0080 BNO
      X=A*U+B*V                                                         0090 BNO
      Y=B*U+A*V                                                         0100 BNO
      RETURN                                                            0110 BNO
      END                                                               0120 BNO
                                                                        0130 BNO

$IBFTC CAUS*
      SUBROUTINE CAUSE(ITYPE,IDNO,ITIME)                                0010 CAS
C                                                                       0020 CAS
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0030 CAS
C                                                                       0040 CAS
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0050 CAS
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0060 CAS
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0070 CAS
      DIMENSION ICORE(1000), CORE(50)                                   0080 CAS
      EQUIVALENCE(ICORE,CORE)                                           0090 CAS
C                                                                       0100 CAS
C                                                                       0110 CAS
C     COMMON AND DIMENSION FOR SIMULATION                               0120 CAS
C                                                                       0130 CAS
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0140 CAS
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0150 CAS
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0160 CAS
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0170 CAS
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DFLDEP,DMTAVE,     0180 CAS
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0190 CAS
     6            DOLTS,DROPAY,DROVRT,DSIC,DW,EVENT,FINDAY,             0200 CAS
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,             0210 CAS
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0220 CAS
     9            HISC42,HISC43,HISC44                                  0230 CAS
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                   0240 CAS
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0250 CAS
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0260 CAS
     3            KINTRL,KSTMES,KTMUP,MAXLQ,NA,NAREA,NC,NDA,            0270 CAS
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0280 CAS
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0290 CAS
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNOMU,PNDSIG,          0300 CAS
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0310 CAS
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0320 CAS
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0330 CAS
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,           0340 CAS
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0350 CAS
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,              0360 CAS
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0370 CAS
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0380 CAS
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,             0390 CAS
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0400 CAS
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0410 CAS
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,              0420 CAS
     9            WATEZ,WT,XDAY,YRS                                     0430 CAS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0440 CAS
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,           0450 CAS
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,           0460 CAS
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0470 CAS
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0480 CAS
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0490 CAS
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),           0500 CAS
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0510 CAS
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,           0520 CAS
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0530 CAS
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) , 0540 CAS
     1           TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,            0550 CAS
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0560 CAS
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0570 CAS
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0580 CAS
C                                                                       0590 CAS
      CALL IDCHEK(IDNO)                                                 0600 CAS
      ICORE(IDNO+1)=ITIME*10+ITYPE                                      0610 CAS
      CALL FILRNK(IDNO,1,4,ICALDR)                                      0620 CAS
      RETURN                                                            0630 CAS
      END                                                               0640 CAS
                                                                        0650 CAS

$IBFTC COLL*
      SUBROUTINE COLECT                                                 0010 COL
C                                                                       0020 COL
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0030 COL
C                                                                       0040 COL
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0050 COL
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0060 COL
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0070 COL
      DIMENSION ICORE(1000), CORE(50)                                   0080 COL
                                                                        0090 COL
      EQUIVALENCE(ICORE,CORE)                                           0100 COL
C                                                                       0110 COL
C                                                                       0120 COL
C     COMMON AND DIMENSION FOR SIMULATION                               0130 COL
C                                                                       0140 COL
      COMMON /BLZ/ AB,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,          0150 COL
     1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,    0160 COL
     2             COLFRT,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,         0170 COL
     3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,            0180 COL
     4             CREWTS,CROSZ,CSPRIC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,    0190 COL
     5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,           0200 COL
     6             DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,            0210 COL
     7             FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,            0220 COL
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,           0230 COL
     9             HISC42,HISC43,HISC44                                 0240 COL
      COMMON /BLZ/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                  0250 COL
     1             ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,          0260 COL
     2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,          0270 COL
     3             KINTRL,KSTMES,KTMOP,MAXLD,NA,NAREA,NC,NDA,           0280 COL
     4             NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,              0290 COL
     5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,             0300 COL
     6             ORDR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,         0310 COL
     7             PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,            0320 COL
     8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,             0330 COL
     9             QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA             0340 COL
      COMMON /BLZ/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,          0350 COL
     1             ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,        0360 COL
     2             SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,             0370 COL
     3             TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,               0380 COL
     4             TONAGE,TOTCUS,TOTTON,TOTWT,TRC,TRCSIN,TRES,          0390 COL
     5             TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,            0400 COL
     6             TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,              0410 COL
     7             TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,              0420 COL
     8             VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,             0430 COL
     9             WATEZ,WT,XDAY,YRS                                    0440 COL
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0450 COL
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,         0460 COL
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,          0470 COL
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0480 COL
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0490 COL
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0500 COL
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),           0510 COL
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0520 COL
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QC(50)     ,        0530 COL
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0540 COL
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0550 COL
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,           0560 COL
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0570 COL
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0580 COL
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0590 COL
C                                                                       0600 COL
  132 NETYP = TNETYP(NT,NDR) + 0.5                                      0610 COL
      IF(TRIP(NT).NE.0.) GO TO 200                                      0620 COL
  100 TRIP(NT) = 1.                                                     0630 COL
      RND = RNNR(0) * 100.                                              0640 COL
      GO TO (202,204,206,208), NETYP                                    0650 COL
  202 CALL HIST(HISTU1,RND,Y)                                           0660 COL
      GO TO 210                                                         0670 COL
  204 CALL HIST(HISTU2,RND,Y)                                           0680 COL
      GO TO 210                                                         0690 COL
  206 CALL HIST(HISTU3,RND,Y)                                           0700 COL
      GO TO 210                                                         0710 COL
  208 CALL HIST(HISTU4,RND,Y)                                           0720 COL
  210 UNACRE = Y                                                        0730 COL
      ACRE = TNOHUN(NT,NDR) * CORACR(NETYP)  / UNACRE                   0740 COL
      CALL RANDEM(PNDMU,PNDSIG,PNDPER)                                  0750 COL
      WATE(NT) = PERUN(NETYP) * PNDPER * DSLC * TNOHUN(NT,NDR)          0760 COL
      WT       =   WT     +  WATE(NT)                                   0770 COL
      SCOLML = SCOLML  +  (ACRE * COLMLK(NETYP) / 5280.)                0780 COL
  200 RND = RNNR(0) * 100.                                              0790 COL
      N3N = DSLC - 1.                                                   0800 COL
      GO TO(271,272,273,274),NETYP                                      0810 COL
  271 GO TO(281,282,283),N3N                                            0820 COL
  272 GO TO(284,285,286),N3N                                            0830 COL
  273 GO TO(287,288,289),N3N                                            0840 COL
  274 GO TO(290,291,292),N3N                                            0850 COL
  281 CALL HIST(HISC12,RND,Y)                                           0860 COL
      GO TO 295                                                         0870 COL
  282 CALL HIST(HISC13,RND,Y)                                           0880 COL
      GO TO 295                                                         0890 COL
  283 CALL HIST(HISC14,RND,Y)                                           0900 COL
      GO TO 295                                                         0910 COL
  284 CALL HIST(HISC22,RND,Y)                                           0920 COL
      GO TO 295                                                         0930 COL
  285 CALL HIST(HISC23,RND,Y)                                           0940 COL
      GO TO 295                                                         0950 COL
  286 CALL HIST(HISC24,RND,Y)                                           0960 COL
      GO TO 295                                                         0970 COL
  287 CALL HIST(HISC32,RND,Y)                                           0980 COL
      GO TO 295                                                         0990 COL
  288 CALL HIST(HISC33,RND,Y)                                           1000 COL
      GO TO 295                                                         1010 COL
  289 CALL HIST(HISC34,RND,Y)                                           1020 COL
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      GO TO 295
  290 CALL HIST(HISC42,RND,Y)                                          1030 COL
      GO TO 295                                                        1040 COL
  291 CALL HIST(HISC43,RND,Y)                                          1050 COL
      GO TO 295                                                        1060 COL
  292 CALL HIST(HISC44,RND,Y)                                          1070 COL
  295 COLRAT = Y                                                       1080 COL
      TTT = TOTWT(NT) + WATEZ                                          1090 COL
      IF(TTT.LT.WATE(NT)) GO TO 700                                    1100 COL
      GO TO 400                                                        1110 COL
  700 TTT2 = TTT + 1000.                                               1120 COL
      IF(TTT2.LT.WATE(NT)) GO TO 710                                   1130 COL
      GO TO 400                                                        1140 COL
  710 TOTWT(NT) = TOTWT(NT) + WATEZ                                    1150 COL
      TRKLD(NT) = WATEZ                                                1160 COL
      GO TO 720                                                        1170 COL
  400 TRKLD(NT) = WATE(NT) - TOTWT(NT)                                 1180 COL
      QQ(NT) = 1.                                                      1190 COL
  720 EVENT(NT) = 3.                                                   1200 COL
      COLTMZ = (TRKLD(NT) * 60.) / COLRAT                              1210 COL
      TIME(NT) = TIME(NT) + COLTMZ                                     1220 COL
      COLHR = COLHR + COLTMZ                                           1230 COL
      RETURN                                                           1240 COL
      END                                                              1250 COL
                                                                       1260 COL

$IBFTC CREA.
      SUBROUTINE CREATE(NUM,IDNO)                                      0010 CRE
C                                                                      0020 CRE
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                0030 CRE
C                                                                      0040 CRE
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2      0050 CRE
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK     0060 CRE
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                 0070 CRE
      DIMENSION ICORE(1000), CORE(50)                                  0080 CRE
      EQUIVALENCE(ICORE,CORE)                                          0090 CRE
C                                                                      0100 CRE
C                                                                      0110 CRE
C                                                                      0120 CRE
C     COMMON AND DIMENSION FOR SIMULATION                              0130 CRE
C                                                                      0140 CRE
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,          0150 CRE
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,    0160 CRE
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,         0170 CRE
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,            0180 CRE
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,    0190 CRE
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,           0200 CRE
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,            0210 CRE
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,            0220 CRE
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,           0230 CRE
     9            HISC42,HISC43,HISC44                                 0240 CRE
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                  0250 CRE
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,          0260 CRE
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,          0270 CRE
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,           0280 CRE
     4            NCR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,              0290 CRE
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,             0300 CRE
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,         0310 CRE
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,            0320 CRE
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,             0330 CRE
     9            QUITMC,QUITTM,QUIT2,R,RGVMAX,RGVMIN,RIGKA            0340 CRE
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,          0350 CRE
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,        0360 CRE
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,             0370 CRE
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,               0380 CRE
     4            TONAGE,TOTCUS,TOTTON,TOTWT,TRC,TRCSIN,TRES,          0390 CRE
     5            TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,            0400 CRE
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,              0410 CRE
     7            TSLHPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,              0420 CRE
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,             0430 CRE
     9            WATEZ,WT,XDAY,YRS                                    0440 CRE
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),          0450 CRE
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,        0460 CRE
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,         0470 CRE
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),         0480 CRE
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),          0490 CRE
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),          0500 CRE
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),          0510 CRE
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),          0520 CRE
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,       0530 CRE
     9           QUITMC(60),QUIT2(300),ROADIS(25),STAT(90)             0540 CRE
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,  0550 CRE
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,          0560 CRE
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),      0570 CRE
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),       0580 CRE
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)               0590 CRE
C
      IF(NUM-8)100,200,600                                             0600 CRE
  200 IF(IFRST8) 900,900,201                                           0610 CRE
  201 CALL REMFST(IDNO,8,IFRST8)                                       0620 CRE
      ICORE(3)=ICORE(3)+1                                              0630 CRE
      GO TO 700                                                        0640 CRE
  100 IF(NUM-4) 300,101,600                                            0650 CRE
                                                                       0660 CRE
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```
 101 IF(IFRST4) 102,102,103
 103 CALL REMEST(IUNO,4,IFRST4)
     GO TO 105
 102 IF(IFRST8) 900,900,104
 104 CALL REMEST(IUNO,8,IFRST8)
     ICORE(IUNO+5)=IDUMM4
     CALL FILEST(IUNO+4,4,IFRST4)
 105 ICORE(2)=ICORE(2)+1
     GO TO 700
 300 IF(NUM-2) 600,301,600
 301 IF(IFRST2) 302,302,303
 303 CALL REMEST(IUNO,2,IFRST2)
     GO TO 304
 302 IF(IFRST4) 305,305,306
 306 CALL REMEST(IUNO,4,IFRST4)
     ICORE(IUNO+3)=IDUMM2
     CALL FILEST(IUNO+2,2,IFRST2)
     GO TO 304
 305 IF(IFRST8)900 ,900,307
 307 CALL REMEST(IUNO,8,IFRST8)
     ICORE(IUNO+3)=IDUMM2
     CALL FILEST(IUNO+2,2,IFRST2)
     ICORE(IUNO+5)=IDUMM4
     CALL FILEST(IUNO+4,4,IFRST4)
 304 ICORE(1)=ICORE(1)+1
 700 ICORE(4)=ICORE(4)+NUM
     J=IUNO+NUM-1
     DO 701 I=IUNO,J
 701 ICORE(I+1)=-1
 800 RETURN
 601 FORMAT(///1X,12HAT ICLOCK = ,I8,13HAND JCHECK = ,I8/1X,
    X15HA BLOCK OF SIZE,I8,12H WAS CREATED/1X,
    Y41HONLY BLOCKS OF SIZE 2,4, OR 8 ARE ALLOWED)
 600 WRITE (IOU,601) ICLOCK,JCHECK,NUM
     ICHECK=2
     CALL PANIC
 901 FORMAT(1H-12HAT ICLOCK = ,I8,13HAND JCHECK = ,I8/
    X29H DYNAMIC STORAGE WAS EXCEEDED)
 900 WRITE (IOU,901) ICLOCK,JCHECK
     ICHECK=1
     GO TO 800
     END


$IBFTC DATM.
      SUBROUTINE DATMAK
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRST8,IOVPHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(10001), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSIMES,KTMDP,MAXLQ,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,
     5            NCTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,UPTM,
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADTS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGML,STAT,SIMEST,STREML,SUMRUT,SUMTRK,
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATE2,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),              0500DATM
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),              0510DATM
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),              0520DATM
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,              0530DATM
     9            QUITMC(60),OUT2(300),ROADIS(25),STAT(90)                  0540DATM
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) , 0550DATM
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,              0560DATM
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),          0570DATM
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),           0580DATM
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                   0590DATM
C                                                                          0600DATM
      IF(COLFRE.EQ.3.) GO TO 10                                            0610DATM
      GO TO (11,11,11,12,12,12),JDW                                        0620DATM
   10 GO TO (12,12,13,13,13,13),JDW                                        0630DATM
   11 DSLC = 4.                                                            0640DATM
      GO TO 14                                                             0650DATM
   12 DSLC = 3.                                                            0660DATM
      GO TO 14                                                             0670DATM
   13 DSLC = 2.                                                            0680DATM
   14 KSTMFS = (STMFST*10.)  +  0.5                                         0690DATM
      INCRMT = (DELDEP*10.0) + 0.5                                         0700DATM
      KTMDP = KSTMFS + (NOTRK*INCRMT)                                      0710DATM
C                                                                          0720DATM
      DIMENSION LX(50)                                                     0730DATM
      CALL RANPER(LX,NOTRK)                                                0740DATM
      INT = 0.                                                             0750DATM
      KKK = KTMDP - 1                                                      0760DATM
C                                                                          0770DATM
      DO 30  I = KSTMFS, KKK                                               0780DATM
      INT = INT + 1                                                        0790DATM
      NT = LX(INT)                                                         0800DATM
      ZI=I                                                                 0810DATM
      ORHR = ORHR + ZI/10.                                                 0820DATM
      TIME(NT)=ZI/10.0                                                     0830DATM
      EVENT(NT) = 1                                                        0840DATM
      CALL CREATE(4,IDNO)                                                  0850DATM
      ITYPE2=EVENT(NT)                                                     0860DATM
      ITIME2=TIME(NT)                                                      0870DATM
      ICORE(IDNO+3)=NT                                                     0880DATM
      CALL CAUSE(ITYPE2,IDNO,ITIME2)                                       0890DATM
   30 CONTINUE                                                             0900DATM
C                                                                          0910DATM
      PRINT 100                                                            0920DATM
      RETURN                                                               0930DATM
  100 FORMAT (1H ,32HTHE LAST TRUCK HAS LEFT THE YARD)                     0940DATM
      END                                                                  0950DATM


$IBFTC DASM*                                                               0010DASM
      SUBROUTINE DAYSUM                                                    0020DASM
C                                                                          0030DASM
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                    0040DASM
C                                                                          0050DASM
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2          0060DASM
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK         0070DASM
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                     0080DASM
      DIMENSION ICORE(1000), CORE(50)                                      0090DASM
      EQUIVALENCE(ICORE,CORE)                                              0100DASM
C                                                                          0110DASM
C                                                                          0120DASM
C     COMMON AND DIMENSION FOR SIMULATION                                  0130DASM
C                                                                          0140DASM
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,              0150DASM
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,        0160DASM
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,             0170DASM
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,                0180DASM
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,        0190DASM
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,               0200DASM
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,                0210DASM
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,                0220DASM
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,               0230DASM
     9            HISC42,HISC43,HISC44                                     0240DASM
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                      0250DASM
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,              0260DASM
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,              0270DASM
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,               0280DASM
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,                  0290DASM
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,                 0300DASM
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,             0310DASM
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,                0320DASM
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,                 0330DASM
     9            QUITMC,QUITTM,OUT2,R,RGVMAX,RGVMIN,RIGKA                 0340DASM
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,              0350DASM
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,            0360DASM
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,                 0370DASM
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                   0380DASM
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,              0390DASM
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,                0400DASM
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                  0410DASM
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,                  0420DASM
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,                 0430DASM
     9            WATEZ,WT,XDAY,YRS                                        0440DASM
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      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0450DASM
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,         0460DASM
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,          0470DASM
     3           CORACR(6) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0480DASM
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0490DASM
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0500DASM
     6           HISC42(16),HISC43(16),HISC44(16),HISTO1(16),           0510DASM
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0520DASM
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,        0530DASM
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0540DASM
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0550DASM
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,           0560DASM
     2           DAYS(2,3), ITIME(2,12), QUITTM(50,6), RKAA(4,2),       0570DASM
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0580DASM
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0590DASM
C                                                                       0600DASM
      DO 12 I = 1, NOTRK                                                0610DASM
      K4 = K4 + 1                                                       0620DASM
      QUT2(K4) = QUITTM(I,JOW) / 60.                                    0630DASM
   12 CONTINUE                                                          0640DASM
C                                                                       0650DASM
      IF(COLFRE.EQ.3.) GO TO 70                                         0660DASM
      GO TO(68,68,68,70,70,70),JOW                                      0670DASM
   68 CRUSZ = 4.                                                        0680DASM
      GO TO 72                                                          0690DASM
   70 CRUSZ = 3.                                                        0700DASM
C                                                                       0710DASM
   72 DO 10 I = 1,NOTRK                                                 0720DASM
      CCL(JOW) = CCL(JOW) + (CSTHR*QUITTM(I,JOW)/60.) + DROPAY +        0730DASM
     1  PAYLBR * (CRUSZ - 1.)                                           0740DASM
   10 CONTINUE                                                          0750DASM
C                                                                       0760DASM
      IF(Q9.EQ.0.) GO TO 20                                             0770DASM
      DO 21 I = 1, NOTRK                                                0780DASM
      CCL(JOW) = CCL(JOW) +(OVRTM(I) * DROVRT) + (OVRTM(I) * OVPAYL *   0790DASM
     1 (CRUSZ - 1.))                                                    0800DASM
   21 CONTINUE                                                          0810DASM
   20 IF(ASSSUN.EQ.0.) GO TO 111                                        0820DASM
C                                                                       0830DASM
      DO 333 I = 51, NOTRC2                                             0840DASM
      CTS(JOW) = CTS(JOW) + (OPTM(I) / 60.) * CSHRTC                    0850DASM
  333 CONTINUE                                                          0860DASM
C                                                                       0870DASM
      XY9 = 0                                                           0880DASM
      XQ8 = Q8 + 480.                                                   0890DASM
C                                                                       0900DASM
      DO 666 I = 51, NOTRC2                                             0910DASM
      IF (QUITMC(I).LE.XQ8) GO TO 666                                   0920DASM
      JXY7 = ((QUITMC(I) - XQ8) / 60.) + 1.                             0930DASM
      XY7 = JXY7                                                        0940DASM
      XY8 = XY7 * Q5                                                    0950DASM
      XY9 = XY9 + XY8                                                   0960DASM
  666 CONTINUE                                                          0970DASM
C                                                                       0980DASM
      ZNOTRC = NOTRC                                                    0990DASM
      XY10 = ZNOTRC * C6                                                1000DASM
      CTS(JOW) = CTS(JOW) + A9 + XY9 + XY10                             1010DASM
  111 TONAGE(JOW) = WT / 2000.                                          1020DASM
      RETURN                                                            1030DASM
      END                                                               1040DASM


$IBFTC DEST*                                                            0010DEST
      SUBROUTINE DESTRY (NUM,IDNO)                                      0020DEST
C                                                                       0030DEST
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0040DEST
C                                                                       0050DEST
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0060DEST
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0070DEST
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0080DEST
      DIMENSION ICORE(1000), CORE(50)                                   0090DEST
      EQUIVALENCE(ICORE,CORE)                                           0100DEST
C                                                                       0110DEST
C                                                                       0120DEST
C     COMMON AND DIMENSION FOR SIMULATION                               0130DEST
C                                                                       0140DEST
      COMMON /BC/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0150DEST
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0160DEST
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0170DEST
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0180DEST
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0190DEST
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0200DEST
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0210DEST
     7            FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,             0220DEST
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0230DEST
     9            HISC42,HISC43,HISC44                                  0240DEST
      COMMON /BD/ HISTO1,HISTU1,HISTU2,HISTU3,HISTU4,                   0250DEST
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIME,JOW,JTRC,           0260DEST
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0270DEST
     3            KINTRL,KSTMES,KTMOP,MAXLQ,NA,NAREA,NC,NDA,            0280DEST
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0290DEST
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0300DEST
     6           ORDR,OVPAYL,OVRTM,PAYLBR,PERUN,PNOMU,PNOSIG,                0310DEST
     7           PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,                   0320DEST
     8           Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,                    0330DEST
     9           QUITMC,QUITIM,QUT2,R,RGVMAX,RGVMIN,RIGKA                    0340DEST
      COMMON /RD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,                 0350DEST
     1           ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,               0360DEST
     2           SRIGMI,STAT,STMEST,STREML,SUMRUT,SUMTRK,                    0370DEST
     3           TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                      0380DEST
     4           TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,                 0390DEST
     5           TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,                   0400DEST
     6           TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                     0410DEST
     7           TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,                     0420DEST
     8           VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,                    0430DEST
     9           WATEZ,WT,XDAY,YRS                                           0440DEST
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),                0450DEST
     1           ASNOPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,              0460DEST
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,               0470DEST
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),               0480DEST
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),                0490DEST
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),                0500DEST
     6           HISC42(16),HISC43(16),HISC44(16),HISTO1(16),                0510DEST
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),                0520DEST
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,             0530DEST
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)                   0540DEST
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,    0550DEST
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,                0560DEST
     2           DAYS(2,3), ITIME(2,12), QUITIM(50,6), RKAA(4,2),            0570DEST
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),             0580DEST
     4           TIMEQ(2,12), INETYP(50,3), INOHUN(50,3)                     0590DEST
C                                                                            0600DEST
      ID=IDNO                                                                0610DEST
      IF(NUM-8) 100,200,600                                                  0620DEST
  200 CALL FILEST(ID,8,IFRST8)                                               0630DEST
      GO TO 800                                                              0640DEST
  100 IF(NUM-4) 300,101,600                                                  0650DEST
  101 IF(ICORE(ID+5)-IDUMM4)102,105,102                                      0660DEST
  102 IF(ICORE(ID-3)-IDUMM4)103,104,103                                      0670DEST
  103 CALL FILEST(ID,4,IFRST4)                                               0680DEST
      ICORE(ID+1)=IDUMM4                                                     0690DEST
      GO TO 800                                                              0700DEST
  105 CALL REMOVE(ID+4,4,IFRST4)                                             0710DEST
      ICORE(ID+5)=0                                                          0720DEST
      GO TO 200                                                              0730DEST
  104 ID=ID-4                                                                0740DEST
      CALL REMOVE(ID,4,IFRST4)                                               0750DEST
      ICORE(ID+1)=0                                                          0760DEST
      GO TO 200                                                              0770DEST
  300 IF(NUM-2) 600,301,600                                                  0780DEST
  301 IF(ICORE(ID+3)-IDUMM2) 302,305,302                                     0790DEST
  302 IF(ICORE(ID-1)-IDUMM2) 303,304,303                                     0800DEST
  303 CALL FILEST(ID,2,IFRST2)                                               0810DEST
      ICORE(ID+1)=IDUMM2                                                     0820DEST
      GO TO 800                                                              0830DEST
  305 CALL REMOVE (ID+2,2,IFRST2)                                            0840DEST
      ICORE(ID+3)=0                                                          0850DEST
      GO TO 101                                                              0860DEST
  304 ID=ID-2                                                                0870DEST
      CALL REMOVE(ID,2,IFRST2)                                               0880DEST
      ICORE(ID+1)=0                                                          0890DEST
      GO TO 101                                                              0900DEST
  800 ICORE(4)=ICORE(4)-NUM                                                  0910DEST
      IF(NUM-4) 801,802,803                                                  0920DEST
  801 ICORE(1)=ICORE(1)-1                                                    0930DEST
      GO TO 804                                                              0940DEST
  802 ICORE(2)=ICORE(2)-1                                                    0950DEST
      GO TO 804                                                              0960DEST
  803 ICORE(3)=ICORE(3)-1                                                    0970DEST
  804 RETURN                                                                 0980DEST
  601 FORMAT(///1X,12HAT ICLOCK = ,I8,12HAND JCHECK = ,I8/1X,                0990DEST
     X16HA BLOCK OF SIZE=,I6,13HWAS DESTROYED/1X,                            1000DEST
     Y41HONLY BLOCKS OF SIZE 2,4, OR 8 ARE ALLOWED)                          1010DEST
  600 WRITE (IOU,601) ICLOCK,JCHECK,NUM                                      1020DEST
      ICHECK=3                                                               1030DEST
      CALL PANIC                                                             1040DEST
      STOP                                                                   1050DEST
      END                                                                    1060DEST


$IBFTC DRIVE*                                                                0010 DRI
      SUBROUTINE DRIVER                                                      0020 DRI
C                                                                            0030 DRI
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                      0040 DRI
C                                                                            0050 DRI
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2            0060 DRI
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK           0070 DRI
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                       0080 DRI
      DIMENSION ICORE(1000), CORE(50)                                        0090 DRI
      EQUIVALENCE(ICORE,CORE)                                                0100 DRI
C                                                                            0110 DRI
C                                                                            0120 DRI
C     COMMON AND DIMENSION FOR SIMULATION                                    0130 DRI
C                                                                            0140 DRI
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      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSIND,
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7            FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSTMES,KTMDP,MAXLQ,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLHPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATEZ,WT,XDAY,YHS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)     ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)     ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
C         DO ONE TIME INITIALIZATION AND PRINT TABLES ONE + TWO
C
      CALL RUNDAT
      CALL ZERINT
      CALL TABL1
      CALL TABL2
      CALL TBLPRN
C
C         DO THE SIMULATION FOR SIX DAYS...
C
      DO 28 I = 1,6
      JDW = 1
      CALL XINIT
      CALL INIT1
      CALL DATMAK
      CALL TIMER
      CALL DAYSUM
   28 CONTINUE
C
C         SUMMARIZE FOR THE WEEK AND PRINT THE FINAL SUMMARY OF ANALYSES
C
      CALL WEEKSM
      CALL FNLPRN
      RETURN
      END


$IBFTC DSPSL*
      SUBROUTINE DISPSL(IONO)
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRSTA,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSIND,
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5            DMIMAX,DMIMIN,DMISIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DRDPAY,DRDVRT,DSEC,DW,EVENT,FINDAY,
     7            FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON ZBUZ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSTMES,KTPOP,MAXLQ,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOELTS,NOTRC,NOTRC2,NOTRK,
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6            ORDR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON ZBUZ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLMI,SMWRKT,
     2            SRTCML,STAT,STMEST,STREML,SUMRUT,SUMTRK,
     3            TAREA,THALOS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCUS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TREHR,TREML,TRETM2,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLOPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATE2,WT,XDAY,YRS
      DIMENSION  AHALOS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNOPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CGRACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)     ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALOS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
      DIMENSION                QTIME(2),NINQ(2)
C
      IF(GW.EQ.1.) GO TO 1
      GW=1.
      QTIME(1)=0.
      QTIME(2)=0.
      NINQ(1)=0
      NINQ(2)=0
    1 K2RIG=0
      K3TRK=1
      FINDAY=0.
      QTM = 0
      IF(ASSSUN.NE.2.) GO TO 906
      IF(ITYPE1.EQ.5) GO TO 30
   22 RND = RNNR(G) * 100.
      CALL HIST(HISTD1,RND,Y)
      DMPTMZ = Y
C
      DO 29 I=1,2
      LD=I
      IF(NINQ(I).EQ.0) GO TO 36
   29 CONTINUE
C
      IF(NINQ(1).LE.NINQ(2)) LD=1
  291 CONTINUE
   31 I=NINQ(LD)+1
      IF(I.GT.11) I=12
      XIC = ITIME1-ITIML(LD,I)
      TIMEQ(LD,I)=TIMEQ(LD,I)+XIC
      ITIML(LD,I)=ITIME1
      ITIML(LD,I+1)=ITIME1
      NINQ(LD)=NINQ(LD) + 1
      IF(NINQ(LD).GT.MAXLQ) MAXLQ=NINQ(LD)
      QTIME(LD)=QTIME(LD)+DMPTMZ
      TIME(NT)=QTIME(LD)
      EVENT(NT)=5.
      CALL CREATE(4,IDNO3)
      ICORE(IDNO+2)=IDNO3
      ICORE(IDNO3+1)=LD
      ICORE(IDNO3+2)=ITIME1
       CORE(IDNO3+3)=DMPTMZ
      GO TO 1002
   30 IDNO3=ICORE(IDNO+2)
      LD=ICORE(IDNO3+1)
   32 ITMIN=ICORE(IDNO3+2)
      DMPTMZ= CORE(IDNO3+3)
      CALL DESTRY(4,IDNO3)
      I=NINQ(LD)+1
      IF(I.GT.11) I=12
      QTM=ITIME1-ITMIN
      QTM=QTM-DMPTMZ
      TIMEQ(LD,I)=TIMEQ(LD,I)+FLOAT(ITIME1-ITIML(LD,I))
      NINGL(L) = NINGL(L) + 1
      ITIME(L,1) = ITIME1
      ITIME(L,I 1)=ITIME1
      GO TO 362
   36 CTIME(L) = ITIME1
      GO TO 291
  362 TSPR = TSPR + DMPTMZ + QTM
      TRPCOL = TRPCOL + 1.
      K2 = K2 + 1
      TSTM(K2) = DMPTMZ + QTM
      CLKTM = TIME(NT)
      IF(ASSGN.EQ.2.) GO TO 905
  906 TRPCOL = TRPCOL + 1.
      K2 = K2 + 1
      RNO = RNGR(0) * 100.
      CALL HISTO(HISTD1,RNO,Y)
      DMPTMZ = Y
      TSPR = TSPR + DMPTMZ
      TSTM(K2) = DMPTMZ
      CLKTM = TIME(NT) + DMPTMZ
  905 IF(LG(NT).EQ.1.) GO TO 37
      EVENT(NT) = 1.
      TIME(NT) = CLKTM
      GO TO 44
   37 CLTTIM(NT,JDW) = CLKTM
      K3TRK=0
      IF(CLKTM.LT.480.) GO TO 80
      OVRTMZ = ((CLKTM - 480.)/60.
      JOVRTM = OVRTMZ
      COVRTM = JOVRTM
      IF(OVRTMZ.LE.COVRTM) GO TO 403
  405 OVRTM(NT) = JOVRTM + 1
      GO TO 409
  403 OVRTM(NT) = JOVRTM
  409 JKTM = OVRTM(NT)
      IF(JKTM.GT.2) GOTO79
      GO TO(77,78),JKTM
   77 NOVRT1 = NOVRT1 + 1
      GO TO 44
   78 NOVRT2 = NOVRT2 + 1
      GO TO 44
   79 NOVRT3 = NOVRT3 + 1
      GO TO 44
   80 URTM = (480. - CLKTM)/2.
      URPR = URPR + URTM
   44 RIGLOD = RIGLOD + TRKLD(NT)
      IF(RIGLOD.LT.RIGMAX) GO TO 999
      RIGLOD=0
C
      DO 222 I = 71,90
      IF (STAT(I).EQ.13.) GO TO 241
  222 CONTINUE
C
      WRITE(ICU,10)
  241 JTRL = I
      STAT(JTRL) = 12
C
      DO 301 I = 71,90
      IF(STAT(I).EQ.10.) GO TO 247
  301 CONTINUE
C
      WRITE(ICU,10)
   10 FORMAT(1H-,34HIMPOSSIBLE TRAILER STATUS IN DSPSL  )
  247 STAT(I) = 13
      DO 321 J = 51,NOTRC2
      IF(STAT(J).EQ.8.) GO TO 909
  321 CONTINUE
      GO TO 999
  909 TRC(J)=J
      TRL(J)=JTRL
      STAT(J) = 9
      STAT(JTRL) = 11
      K2RIG=1
  999 IF(K2RIG.EQ.0.AND.K3TRK.EQ.C) GO TO 1000
      IF(K3TRK.EQ.0) GO TO 1001
      IF(K2RIG.EQ.0) GO TO 1002
      CALL CREATE(4,IDNO2)
      ITYPE2 = EVENT(NT) + .5
      ITIME2 = TIME(NT) + .5
      IC(REF(IDNO2 + 3)) = NT
      CALL CAUSE (ITYPE2,IDNO2,ITIME2)
      GO TO 1001
 1000 FINDAY=99.
      GO TO 1002
 1001 NT=J
      EVENT(NT)=7
      TIME(NT)=CLKTM+5.
 1002 RETURN
      END
```

```
$IBFTC FILF.
      SUBROUTINE FILEST(IDNO,IP,IOWN)
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALOR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLFRE,COLHR,COLMLK,COLTM2,COMPAP,CONA,CONB,
     3            CONC,CONO,CONE,CONF,COSCOL,CORACR,COSIND,
     4            CREWTS,CRUS7,CSPRTC,CSTHR,CTS,DAYS,DFLDEP,DMTAVE,
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DROPAY,DROVRT,ESLC,DW,EVENT,FINDAY,
     7            FLAINO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSTMES,KTMOP,MAXLO,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOELTS,NOTRC,NOTRC2,NOTRK,
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PRBELT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TREHR,TREML,TRETM2,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATE2,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOH  I(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
      CALL IDCHEK(IDNO)
      CALL UNPACK(IOWN,IFIRST,LAST)
      IF(IFIRST) 200,200,201
  200 CALL PACK(IOWN,IDNO,IDNO)
      IXX=IDNO+IP
      ICORE( IXX   )=0
  202 RETURN
  201 IXX=IDNO+IP
      CALL PACK(ICORE( IXX   ),0,IFIRST)
      IXX=IFIRST+IP
      CALL UNPACK(ICORE( IXX      ),JP,JS)
      IXX=IFIRST+IP
      CALL PACK(ICORE( IXX      ),IDNO,JS)
      CALL PACK(IOWN,IDNO,LAST)
      GO TO 202
      END
```

```
$IBFTC FILA.
      SUBROUTINE FILAST(IDNO,IP,IOWN)
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALOR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
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```
C      COMMON AND DIMENSION FOR SIMULATION
C
       COMMON /BD/ A9,ACRE,AHALOS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2             COLFRF,COLMR,COLMLK,COLTM2,COMPAP,CONA,CONB,
     3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,
     4             CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6             DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7             FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9             HISC42,HISC43,HISC44
       COMMON /PC/ HISTO1,HISTU1,HISTU2,HISTU3,HISTU4,
     1             ICOLER,IN,INCRMT,IOL,IRUNNO,ITIME,JDW,JTRC,
     2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3             KINTRL,KSTMES,KTMDP,MAXLG,NA,NAREA,NC,NDA,
     4             NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,
     5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6             OPHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNOMU,PNOSIG,
     7             PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9             QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
       COMMON /PE/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1             ROADIS,RMXDSR,RMXDST,RNO,RUNNO,SCOLML,SMWRKT,
     2             SRIGML,STAT,SIMEST,STREML,SUMRUT,SUMTRK,
     3             TAREA,THALDS,TIME,TIMEQ,INFTYP,INOHUN,
     4             TONAGE,TOTCLS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5             TREPP,TREML,TRETM2,TRIP,TRKDAY,TRKLD,TRL,
     6             TRLDAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7             TSLOPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8             VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9             WATE2,WT,XDAY,YRS
       DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1            ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,
     2            AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3            CORACR(4) ,CTS(6)    ,EVENT(60) ,HISC12(16),
     4            HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5            HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6            HISC42(16),HISC43(16),HISC44(16),HISTO1(16),
     7            HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8            OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,
     9             QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
       DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) ,
     1            TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,
     2            DAYS(2,3), ITIME(2,12), QUITTM(50,6), RKAA(4,2),
     3            RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4            TIMEQ(2,12), INFTYP(50,3), INOHUN(50,3)
C
       CALL IDCHEK(IDNO)
       CALL UNPACK(ICWN,IFIRST,LAST)
       IF(LAST) 200,200,201
   200 CALL PACK(ICWN,IDNO,IDNO)
       IXX=IDNO+IP
       ICORE(IXX)=0
   202 RETURN
   201 IXX=IDNO+IP
       CALL PACK(ICORE( IXX   ),LAST,0)
       IXX=LAST+IP
       CALL UNPACK(ICORE(IXX    ),JP,JS)
       IXX=LAST+IP
       CALL PACK(ICORE( IXX   ),JP,IDNO)
       CALL PACK(ICWN,IFIRST,IDNO)
       GO TO 202
       END


$IBFTC FILR.
       SUBROUTINE FILRNK(IDNO,IRANK,IP,ICWN)
C
C      COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
       COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
       COMMON IFRST4,IFRSTR,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
       COMMON MAXCRE,MAXINT,MAXI,ITYPE1
       DIMENSION ICORE(1000), CORE(50)
       EQUIVALENCE(ICORE,CORE)
C
C
C      COMMON AND DIMENSION FOR SIMULATION
C
       COMMON /BD/ A9,ACRE,AHALOS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2             COLFRF,COLMR,COLMLK,COLTM2,COMPAP,CONA,CONB,
     3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,
     4             CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6             DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7             FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9             HISC42,HISC43,HISC44
       COMMON /PC/ HISTO1,HISTU1,HISTU2,HISTU3,HISTU4,
     1             ICOLER,IN,INCRMT,IOL,IRUNNO,ITIME,JDW,JTRC,
     2              JTPL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPIS,KINTRK,              0270 FLR
     3              KINTRL,KSTMES,KTMOP,MAXLG,NA,NAREA,NC,NDA,               0280 FLR
     4              NGR,NN,NORUT,NOELTS,NOTRC,NOTRC2,NOTRK,                  0290 FLR
     5              NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,                 0300 FLR
     6              OPRR,OVPAYL,OVRTM,PAYLRR,PERUN,PNDMU,PNDSIG,             0310 FLR
     7              PRRFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,                0320 FLR
     8              Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,                 0330 FLR
     9              QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA                 0340 FLR
      COMMON /B07/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,               0350 FLR
     1              ROADTS,RMXDSR,RMXDST,RNU,RUNNO,SCOLML,SMWRKT,            0360 FLR
     2              SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,                 0370 FLR
     3              TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                   0380 FLR
     4              TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,              0390 FLR
     5              TREMR,TREML,TREIPZ,TRIP,TRKDAY,TRKLD,TRL,                0400 FLR
     6              TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                  0410 FLR
     7              TSLRPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,                  0420 FLR
     8              VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,                 0430 FLR
     9              WATE2,WT,XDAY,YRS                                        0440 FLR
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),                0450 FLR
     1           ASNORT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,              0460 FLR
     2           AY1(25)    ,AY2(25), B(10),CCL(6),CULMLK(4) ,               0470 FLR
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),               0480 FLR
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),                0490 FLR
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),                0500 FLR
     6           HISC42(16),HISC43(16),HISC44(16),HISTO1(16),                0510 FLR
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),                0520 FLR
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)  ,QQ(50)     ,              0530 FLR
     9            QUITMC(60),QUT2(300),ROADTS(25),STAT(90)                   0540 FLR
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,    0550 FLR
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,                0560 FLR
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),            0570 FLR
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),             0580 FLR
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                     0590 FLR
C                                                                            0600 FLR
      CALL IDCHEK(IDNO)                                                      0610 FLR
      IR=IRANK                                                               0620 FLR
      MOD=0                                                                  0630 FLR
      IF(IR) 90,90,91                                                        0640 FLR
   90 MOD=1                                                                  0650 FLR
      IR=-IR                                                                 0660 FLR
   91 IF(MOD) 100,100,101                                                    0670 FLR
  100 IXX=IDNO+IR                                                            0680 FLR
      K=ICORE( IXX    )                                                      0690 FLR
      GO TO 102                                                              0700 FLR
  101 IXX=IDNO+IR                                                            0710 FLR
      XK=CORE(  IXX    )                                                     0720 FLR
  102 CALL UNPACK(IOWN,IFIRST,LAST)                                          0730 FLR
      L=LAST                                                                 0740 FLR
      IF(L)103,103,104                                                       0750 FLR
  103 CALL PACK(IOWN,IDNO,IDNO)                                              0760 FLR
      IXX=IDNO+IP                                                            0770 FLR
      ICORE( IXX    )=0                                                      0780 FLR
  105 RETURN                                                                 0790 FLR
  104 IF(MOD)106,106,122                                                     0800 FLR
  106 IXX=L+IR                                                               0810 FLR
      IF(ICORE( IXX)-K)107,107,108                                           0820 FLR
  122 IXX=L+IR                                                               0830 FLR
      IF(CORE(IXX )-XK) 107,107,108                                          0840 FLR
  107 CALL FILAST(IDNO,IP,IOWN)                                              0850 FLR
      GO TO 105                                                              0860 FLR
  108 JSUC=L                                                                 0870 FLR
      IXX=L+IP                                                               0880 FLR
      CALL UNPACK(ICORE( IXX),JP,JS)                                         0890 FLR
      L=JP                                                                   0900 FLR
  114 IF(L)115,115,116                                                       0910 FLR
  115 CALL FILFST(IDNO,IP,IOWN)                                              0920 FLR
      GO TO 105                                                              0930 FLR
  116 IF(MOD) 119,119,120                                                    0940 FLR
  119 IXX=L+IR                                                               0950 FLR
      IF(ICORE( IXX)-K)121,121,108                                           0960 FLR
  120 IXX=L+IR                                                               0970 FLR
      IF(CORE( IXX)-XK) 121,121,108                                          0980 FLR
  121 IXX=IDNO+IP                                                            0990 FLR
      CALL PACK(ICORE( IXX    ),L,JSUC)                                      1000 FLR
      IXX=L+IP                                                               1010 FLR
      CALL UNPACK(ICORE( IXX),JP,JS)                                         1020 FLR
      CALL PACK(ICORE(IXX ),JP,IDNO)                                         1030 FLR
      IXX=JSUC+IP                                                            1040 FLR
      CALL UNPACK(ICORE( IXX    ),JP,JS)                                     1050 FLR
      CALL PACK(ICORE( IXX    ),IDNO,JS)                                     1060 FLR
      GO TO 105                                                              1070 FLR
      END                                                                    1080 FLR


$IBFTC FNLP2                                                                 0010FNLP
       SUBROUTINE FNLPRN                                                     0020FNLP
C                                                                            0030FNLP
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                      0040FNLP
C                                                                            0050FNLP
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2            0060FNLP
      COMMON IFRST4,IFRSTR,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK           0070FNLP
      COMMON MAXCRE,MAXINT,MAXI,ITYPE1                                       0080FNLP
      DIMENSION ICORE(1000), CORE(50)                                        0090FNLP
      EQUIVALENCE(ICORE,CORE)                                           0100FNLP
C                                                                       0110FNLP
C     COMMON AND DIMENSION FOR SIMULATION                               0120FNLP
C                                                                       0130FNLP
      COMMON /ZHZ/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0140FNLP
     1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,    0150FNLP
     2             COLFRE,COLHR,COLMEK,COLTMZ,COMPAP,CONA,CONB,         0160FNLP
     3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSEND,            0170FNLP
     4             CREWTS,CRUSZ,CSPRIC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,    0180FNLP
     5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,           0190FNLP
     6             DOLTS,DROPAY,DROVRT,DSEC,DW,EVENT,FINDAY,            0200FNLP
     7             FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,            0210FNLP
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,           0220FNLP
     9             HISC42,HISC43,HISC44                                 0230FNLP
      COMMON /ZHZ/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                  0240FNLP
     1             ICOLTR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,          0250FNLP
     2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,          0260FNLP
     3             KINTRL,KSTMES,KTMOP,MAXLG,NA,NAREA,NC,NDA,           0270FNLP
     4             NDP,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,              0280FNLP
     5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,             0290FNLP
     6             ORPR,OVPAYL,OVRTM,PAYLHR,PERUN,PNDMU,PNDSIG,         0300FNLP
     7             PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,            0310FNLP
     8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,             0320FNLP
     9             QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA             0330FNLP
      COMMON /ZHZ/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,          0340FNLP
     1             ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,        0350FNLP
     2             SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,             0360FNLP
     3             TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,               0370FNLP
     4             TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,          0380FNLP
     5             TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,            0390FNLP
     6             TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,              0400FNLP
     7             TSLRPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,              0410FNLP
     8             VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,             0420FNLP
     9             WATEZ,WT,XDAY,YRS                                    0430FNLP
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0440FNLP
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,           0450FNLP
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMEK(4) ,           0460FNLP
     3           CORACR(4) ,CTS(6)    ,EVENT(60) ,HISC12(16),           0470FNLP
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0480FNLP
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0490FNLP
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),           0500FNLP
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0510FNLP
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,           0520FNLP
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0530FNLP
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0540FNLP
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,           0550FNLP
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0560FNLP
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3).        0570FNLP
     4           TIMEQ(2,12), INETYP(50,3), TNOHUN(50,3)                0580FNLP
C                                                                       0590FNLP
      JFLTS = TRCSIN                                                    0600FNLP
      JTRPCL = TRPCOL                                                   0610FNLP
      JTRPRG = TRPRIG                                                   0620FNLP
C                                                                       0630FNLP
 8041 FORMAT(1H1/1H-/1H-,                                               0640FNLP
     1 45X,50HIN THIS RUN,  THERE ARE NO LARGE HAUL  TRAILERS OR        0650FNLP
     2/41X,55HTRANSFER STATION,THE COLLECTION TRUCKS MAKE THE HAUL TO   0660FNLP
     3/41X,55HTHE FINAL DISPOSAL SITE,WHICH IS LOCATED AT COORDINATES,  0670FNLP
     4/41X, 4HFX =,F9.1,6H, FY =,F9.1,28H.  THE  MAP TITLED  'MAP FOR   0680FNLP
     5/41X,15HSIMULATION RUN I3,37HSHOWS THE RESIDENTIAL AREAS DIVISIONS0690FNLP
     6/41X,55HAND THIS DISPOSAL SITE. THE RUN HAS SIMULATED ONE WEEKS   0700FNLP
     7/41X,42HOPERATION AND THE RESULTS ARE SHOWN BELOW.)               0710FNLP
C                                                                       0720FNLP
 8061 FORMAT(1H1/1H-/1H-,                                               0730FNLP
     1 45X,50HIN THIS RUN THERP IS A TRANSFER STATION WHERE THE         0740FNLP
     2/41X,55HCOLLECTION TRUCKS BRING THEIR LOADS. THE SOLID WASTE IS   0750FNLP
     3/41X,14HTRANSFERRED TO I4,37H CUBIC  YARD TRAILERS  AND CARRIED IN0760FNLP
     4/41X,55HTHESE TRAILERS PULLED BY TRACTORS TO THE FINAL DISPOSAL   0770FNLP
     5/41X,55HSITE.  THE TRANSFER STATION IN THIS RUN HAS A  CAPACITY   0780FNLP
     6/41X,2HOF,I4,49H TONS PER DAY AND REQUIRES AN INITIAL  INVESTMENT 0790FNLP
     7/41X,4HOF $F9.2,42H,THE FINAL DISPOSAL SITE IS AT COORDINATES,    0800FNLP
     8/41X,4HFX =,F7.0, 6H, FY =,F7.0,31H THE TRANSFER STATION IS AT CO-0810FNLP
     9/41X,15HORDINATES, TX =,F8.0,6H, TY =,F8.0,20H THE DISTANCE FROM  0820FNLP
     1/41X,50HTHE TRANSFER STATION TO THE FINAL DISPOSAL SITE IS,F5.1  /0830FNLP
     241X7HMILES. I3,14H TRAILERS AND I3,28H  TRACTORS  WORK  OUT OF THE0840FNLP
     3/41X,17HTRANSFER STATION.                                         0850FNLP
     4/1H0,45X,38HTHE MAP TITLED 'MAP FOR SIMULATION RUN,I5,7H  SHOWS   0860FNLP
     5/41X,55HTHE RESIDENTIAL AREA DIVISIONS AND THE LOCATIONS OF THE   0870FNLP
     6/41X,55HTRANSFER STATION AND THE FINAL  DISPOSAL SITE.  THE RUN   0880FNLP
     7/41X,55HHAS SIMULATED ONE WEEKS OPERATION, AND THE  RESULTS ARE   0890FNLP
     8/41X,12HSHOWN BELOW.                                              0900FNLP
C                                                                       0910FNLP
 8062 FORMAT(                                                           0920FNLP
     11H0,  40X,44H1. COST OF COLLECTION TRUCKS OPERATION   ....,F11.2/ 0930FNLP
     21H0,  40X,44H2. COST OF TRANSFER STATION AND              /       0940FNLP
     31H ,  40X,44H              TRAILER TRACTOR OPERATION  ....,F11.2/ 0950FNLP
     41H0,  40X,44H3. TOTAL COST OF WEEKS ACTIVITY   ...........,F11.2/ 0960FNLP
     51H0,  40X,44H4. TONNAGE COLLECTED IN WEEK   ..............,F11.2/ 0970FNLP
     61H0,  40X,44H5. DOLLARS PER TON COST FOR COLLECTION       /       0980FNLP
     71H ,  40X,44H                        TRUCKS UPERATION  ....,F11.2/ 0990FNLP
     81H0,  40X,44H6. DOLLARS PER TON COST FOR TRANSFER        /        1000FNLP
     91H ,  40X,44H           STATION AND TRACTOR UPERATION  ....,F11.2/ 1010FNLP
     11H0,  46X,44H7. DOLLARS PER TON FOR ENTIRE WEEKS WORK ....,F11.2/
     21H0,  46X,44H8. COLLECTION TRUCK TRAFFIC MILEAGE  ........,F11.1/
     31H0,  46X,44H9. COLLECTION TRUCK NEIGHBORHOOD MILEAGE ....,F11.1/
     41H0, 39X,45H10. TRAILER TRACTOR TRAFFIC MILEAGE  ..........,F11.1/
     51H1/1H-/1H-/1H ,39X,39H11. NUMBER OF COLLECTION TRUCKS GETTING/
     61H , 39X,45H    ONE HOUR OF OVERTIME DURING WEEK  ........,I6/
     71H0, 39X,45H12. NUMBER OF COLLECTION TRUCKS GETTING       /
     81H , 39X,45H    TWO HOURS OF OVERTIME DURING WEEK  .......,I6/
     91H0, 39X,45H13. NUMBER OF TRUCKS GETTING MORE THAN        /
     11H , 39X,45H    TWO HOURS OF OVERTIME DURING WEEK  .......,I6)
C
 8063 FORMAT(
     11H0,   39X,14H14. THERE WERE,I4,29H  BREAKDOWNS OR FLAT TIRES ON/
     21H ,   39X,45H     COLLECTION TRUCKS DURING THE WEEK.        /
     31H0,   39X,30H15. THE COLLECTION TRUCKS MADE,I6,13H TRIPS DURING/
     41H ,   39X,13H     THE WEEK./
     51H0,   39X,33H16. THE TRAILER TRACTOR RIGS MADE,I6, 6H TRIPS/
     61H ,   39X,20H     DURING THE WEEK./
     71H0,   39X,45H                            AVE   SIG   MAX   MIN /
     81H ,   39X,21H17. TIME IN MINUTES  /
     91H ,   39X,21H     IN DISPOSAL ......, 4F6.2/
     11H0,   39X,45H18. PERCENT TIME SPENT BY COLLECTION TRUCKS  /
     21H ,   39X,28H              IN COLLECTING....,F9.1/
     31H ,   39X,28H              IN TRAFFIC ......,F9.1/
     41H ,   39X,28H              IN DISPOSAL .....,F9.1/
     51H ,   39X,28H              OFF ROUTE .......,F9.1/
     61H0,40X,45H                            AVE   SIG   MAX   MIN /
     71H ,   39X,21H19. HOURS IN WORKDAY ,4F6.1)
C
 8064 FORMAT(
     11H0,39X,30H21. MAXIMUM LENGTH OF QUEUE IS,I6/
     21H0,39X,19H22. RESUME OF WEEK/
     31H , 42X,40H    DAY   WEIGHT COLLECTED   COST OF DAY/
     41H , 42X,40H                IN TONS         IN DOLLARS)
C
 8065 FORMAT(1H0,43X,12HMONDAY.......,F9.2,F17.2/1H ,43X,12HTUESDAY......,
     1F9.2,F17.2/1H ,43X,12HWEDNESDAY....,F9.2,F17.2/1H ,43X,12HTHURSDAY.
     2....,F9.2,F17.2/1H ,43X,12HFRIDAY.......,F9.2,F17.2/1H ,43X,12HSATUR
     3DAY.....,F9.2,F17.2)
C
 8066 FORMAT(1H1/1H-/1H-/1H ,39X,31H23. NUMBER OF TRIPS BY TRAILERS)
C
 8067 FORMAT(
     11H ,39X,11H    TRAILER,I4, 5H MADE,I4  ,19H TRIPS DURING WEEK.)
C
 8068 FORMAT(1H0,39X,31H24. NUMBER OF TRIPS BY TRACTORS)
C
 8069 FORMAT(
     11H ,39X,11H    TRACTOR,I4, 5H MADE,I4  ,19H TRIPS DURING WEEK.)
C
 8081 FORMAT(1H1/1H-/1H-/
     A1H ,         39X,33H20. PERCENT OF TIME THAT TRANSFER/
     11H ,         43X,19HSTATION QUEUES WERE/
     21H ,         49X,33H                   QUEUE 1   QUEUE 2/
     31H ,         49X,15H     NO TRUCKS ,F7.2,F10.2/
     41H ,         49X,15H    ONE TRUCK  ,F7.2,F10.2/
     51H ,         49X,15H    TWO TRUCKS ,F7.2,F10.2/
     61H ,         49X,15H  THREE TRUCKS , F7.2,F10.2/
     61H ,         49X,15H   FOUR TRUCKS , F7.2,F10.2/
     61H ,         49X,15H   FIVE TRUCKS , F7.2,F10.2/
     61H ,         49X,15H    SIX TRUCKS , F7.2,F10.2/
     61H ,         49X,15H  SEVEN TRUCKS , F7.2,F10.2/
     61H ,         49X,15H  EIGHT TRUCKS , F7.2,F10.2/
     61H ,         49X,15H   NINE TRUCKS , F7.2,F10.2/
     61H ,         49X,15H    TEN TRUCKS , F7.2,F10.2/
     51H ,         49X,15H           MORE ,F7.2,F10.2)
C
  502 FORMAT(1H1/1H-/1H-/
     21H ,39X,18H20. RESUME OF WEEK/
     31H , 39X,40H    DAY   WEIGHT COLLECTED   COST OF DAY/
     41H , 39X,40H                IN TONS         IN DOLLARS)
C
  614 FORMAT(1H0,39X,36H25. NUMBER OF TRACTORS GETTING  ONE /
    1         1H , 39X,40H    HOUR OF OVERTIME DURING WEEK ........,I3/
    2         1H0,39X,36H26. NUMBER OF TRACTORS GETTING  TWO /
    3         1H ,39X,40H    HOURS OF OVERTIME DURING WEEK .......,I3/
    4         1H0,39X,36H27. NUMBER OF TRACTORS GETTING MORE /
    5         1H ,39X,40H    THAN TWO HOURS OF OVERTIME ..........,I3)
  661 FORMAT(1H-      ,43X,47HSTATEMENTS 20  AND  21 BELOW ARE NOT APPLICA
     1BLE/1H ,43X,47HAS UNLIMITED  UNLOADING  SPACES  EXIST  AT  THE/
     21H ,42X,18H TRANSFER STATION.)
C
C
      IF(ASSSUN.EQ.0.) GO TO 201
      WRITE(ICU,8061)KINTRL,KAPTS,DOLTS,FX,FY,TX,TY,TRLHAL,NOTRL,NOTRC,
     1IRUNNO
      GO TO 202
  201 WRITE (ICU,8041) FX,FY,IRUNNO
  202 WRITE(ICU,8062)COSCOL,TSCOST,TOTCOS,TOTTON,DCLCOL,DOLRIG,DOLTON,ST
     1REML,SCOLML,SRIGML,NOVRT1,NOVRT2,NOVRT3
      WRITE(ICU,8063)JFLTS,ITRPCL,JTRPRG,DMTAVE,DMTSIG,DMTMAX,DMTMIN,
    1 CCLHR,TRLHR,TSHR,CRHR,QUIAVE,QUISIG,QUIMAX,QUIMIN                   1930FNLP
      IF(ASSSUN.NE.1.) GO TO 662                                         1940FNLP
      WRITE(IOU,661)                                                     1950FNLP
C                                                                        1960FNLP
  662 IF (ASSSUN.EQ.0.) GO TO 777                                        1970FNLP
      WRITE(IOU,8081) TIMEQ(1,1),TIMEQ(2,1),TIMEQ(1,2),TIMEQ(2,2),       1980FNLP
     1                TIMEQ(1,3),TIMEQ(2,3),TIMEQ(1,4),TIMEQ(2,4),       1990FNLP
     2                TIMEQ(1,5),TIMEQ(2,5),TIMEQ(1,6),TIMEQ(2,6),       2000FNLP
     3                TIMEQ(1,7),TIMEQ(2,7),TIMEQ(1,8), TIMEQ(2,8),      2010FNLP
     4                TIMEQ(1,9),TIMEQ(2,9),TIMEQ(1,10),TIMEQ(2,10),     2020FNLP
     5                TIMEQ(1,11),TIMEQ(2,11),TIMEQ(1,12),TIMEQ(2,12)    2030FNLP
      WRITE(IOU,8064)MAXEQ                                               2040FNLP
C                                                                        2050FNLP
C                    DIMENSION REQUIRED IN THIS ROUTINE ONLY             2060FNLP
      DIMENSION XX(6)                                                    2070FNLP
C                                                                        2080FNLP
  777 DO 902 I = 1,6                                                     2090FNLP
      XX(I) = CCL(I) + CTS(I)                                            2100FNLP
  902 CONTINUE                                                           2110FNLP
C                                                                        2120FNLP
      IF(ASSSUN.NE.0.) GO TO 500                                         2130FNLP
      WRITE(IOU,502)                                                     2140FNLP
  500 WRITE(IOU,8065)TONAGE(1),XX(1),TONAGE(2),XX(2),                    2150FNLP
     1                TONAGE(3),XX(3),TONAGE(4),XX(4),                   2160FNLP
     2                TONAGE(5),XX(5),TONAGE(6),XX(6)                    2170FNLP
C                                                                        2180FNLP
      IF(ASSSUN.EQ.0.) GO TO 778                                         2190FNLP
      WRITE(IOU,8066)                                                    2200FNLP
C                                                                        2210FNLP
      DO 33 I = 71,90                                                    2220FNLP
      IF(TRIP(I).EQ.0.) GO TO 34                                         2230FNLP
   33 CONTINUE                                                           2240FNLP
C                                                                        2250FNLP
   34 JJKK = I - 1                                                       2260FNLP
C                                                                        2270FNLP
      DO 45 J = 71, JJKK                                                 2280FNLP
      J77 = TRIP(J)                                                      2290FNLP
      WRITE(IOU,8067) J,J77                                              2300FNLP
   45 CONTINUE                                                           2310FNLP
C                                                                        2320FNLP
      WRITE(IOU,8068)                                                    2330FNLP
C                                                                        2340FNLP
      DO 331 I = 51, NOTRC2                                              2350FNLP
      J78 = TRIP(I)                                                      2360FNLP
      WRITE( IOU,8069) I,J78                                             2370FNLP
  331 CONTINUE                                                           2380FNLP
C                                                                        2390FNLP
      MM1 = B(1)                                                         2400FNLP
      MM2 = B(2)                                                         2410FNLP
      MM3 = B(3)                                                         2420FNLP
      WRITE (IOU,614) MM1,MM2,MM3                                        2430FNLP
  778 RETURN                                                             2440FNLP
      END                                                                2450FNLP


$IBFTC HIST*                                                             0010 HST
      SUBROUTINE HIST(ZZ,RND,YY)                                         0020 HST
      DIMENSION X(20),Y(20),Z(20),ZZ(1)                                  0030 HST
      N=ZZ(1)                                                            0040 HST
      ZN=N                                                               0050 HST
      NN=N+1                                                             0060 HST
      YMIN=ZZ(2)                                                         0070 HST
      YMAX=ZZ(3)                                                         0080 HST
      DELY=(YMAX-YMIN)/ZN                                                0090 HST
      DO 4001 I=1,N                                                      0100 HST
 4001 Z(I)=ZZ(I+3)                                                       0110 HST
      DO 4002 I = 1,NN                                                   0120 HST
      ZI=I                                                               0130 HST
 4002 Y(I)=YMIN+(ZI-1.0)*DELY                                            0140 HST
      X(1)=Z(1)                                                          0150 HST
      DO 4004 I=2,N                                                      0160 HST
 4004 X(I)=X(I-1)+Z(I)                                                   0170 HST
      YY=Y(1)+RND*DELY/Z(1)                                              0180 HST
      DO 4006 I=2,NN                                                     0190 HST
      IF(RND.LT.X(I-1)) GO TO 4008                                       0200 HST
 4006 YY=Y(I)+(DELY*(RND-X(I-1))/Z(I))                                   0210 HST
 4008 RETURN                                                             0220 HST
      END                                                                0230 HST


$IBFTC IDCH*                                                             0010IDCK
      SUBROUTINE IDCHEK(ICNO)                                            0020IDCK
C                                                                        0030IDCK
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                  0040IDCK
C                                                                        0050IDCK
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2        0060IDCK
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK       0070IDCK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                   0080IDCK
      DIMENSION ICORE(1000), CORE(50)                                    0090IDCK
      EQUIVALENCE(ICORE,CORE)                                            0100IDCK
C                                                                        0110IDCK
C                                                                        0120IDCK
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C     COMMON AND DIMENSION FOR SIMULATION                                0130IDCK
C                                                                        0140IDCK
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,            0150IDCK
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,      0160IDCK
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,           0170IDCK
     3            CONC,COND,CONF,CONF,COSCOL,CORACR,COSLND,              0180IDCK
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,      0190IDCK
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,             0200IDCK
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,              0210IDCK
     7            FLAINO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,              0220IDCK
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,             0230IDCK
     9            HISC42,HISC43,HISC44                                   0240IDCK
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                    0250IDCK
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,            0260IDCK
     2            JTRL, JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0270IDCK
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,             0280IDCK
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,                0290IDCK
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,               0300IDCK
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,           0310IDCK
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,              0320IDCK
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,               0330IDCK
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA               0340IDCK
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,            0350IDCK
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCULML,SMWRKT,          0360IDCK
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,               0370IDCK
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                 0380IDCK
     4            TONAGE,TOTCUS,TOTTON,TOTWT,TRC,TRCSIN,TRES,            0390IDCK
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,              0400IDCK
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                0410IDCK
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,                0420IDCK
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,               0430IDCK
     9            WATE7,WT,XDAY,YRS                                      0440IDCK
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),            0450IDCK
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,            0460IDCK
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,            0470IDCK
     3           CURACR(4) ,CTS(6)    ,EVENT(60) ,HISC12(16),            0480IDCK
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),            0490IDCK
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),            0500IDCK
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),            0510IDCK
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),            0520IDCK
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,            0530IDCK
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)               0540IDCK
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0550IDCK
     1           TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,             0560IDCK
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),        0570IDCK
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),         0580IDCK
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                 0590IDCK
C                                                                        0600IDCK
      IF(IDNO-IOVRHD) 10,20,20                                           0610IDCK
   20 IF(IDNO-MAXCRE)30,10,10                                            0620IDCK
   30 RETURN                                                             0630IDCK
   10 ICHECK=4                                                           0640IDCK
      CALL PANIC                                                         0650IDCK
      STOP                                                               0660IDCK
      END                                                                0670IDCK


$IBFTC INIT.                                                             0010 INI
      SUBROUTINE INITL                                                   0020 INI
C                                                                        0030 INI
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                  0040 INI
C                                                                        0050 INI
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2        0060 INI
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK       0070 INI
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                   0080 INI
      DIMENSION ICORE(1000), CORE(50)                                    0090 INI
      EQUIVALENCE (ICORE,CORE)                                           0100 INI
C                                                                        0110 INI
C     COMMON AND DIMENSION FOR SIMULATION                                0120 INI
C                                                                        0130 INI
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,            0140 INI
     1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0150 INI
     2             COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0160 INI
     3             CONC,COND,CONF,CONF,COSCOL,CORACR,COSLND,             0170 INI
     4             CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0180 INI
     5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0190 INI
     6             DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0200 INI
     7             FLAINO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,             0210 INI
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0220 INI
     9             HISC42,HISC43,HISC44                                  0230 INI
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                    0240 INI
     1             ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0250 INI
     2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0260 INI
     3             KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,            0270 INI
     4             NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0280 INI
     5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0290 INI
     6             ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0300 INI
     7             PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0310 INI
     8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0320 INI
     9             QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0330 INI
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,            0340 INI
     1          ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2          SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,
     3          TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4          TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5          TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,
     6          TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7          TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8          VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9          WATEZ,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1          ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,
     2          AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3          CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4          HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5          HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6          HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7          HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8          OPTM(60)   ,OVRTM(50)  ,PERUN(4)   ,QQ(50)     ,
     9           QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)   ,TONAGE(6)  ,TOTWT(50)  ,TRC(60)    ,TRIP(90) ,
     1          TRKLD(50)  ,TRL(60)    ,TSTM(1000),WATE(50) ,
     2          DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),

     3          RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4          TIMEQ(2,12), TNETYP(5C,3), TNOHUN(50,3)
C
      DW=0.
      IF(COLFRE.EQ.2.) GO TO 100
      GO TO (2,3,2,3,2,3), JDW
    2 NDR = 1
      GO TO 600
    3 NDR = 2
      GO TO 600
  100 GO TO (2,3,4,2,3,4), JDW
    4 NDR = 3
  600 NOTRK = XDAY+0.5
      IF (THALDS(NOTRK,NDR) . NE.0.) GO TO 700
      NOTRK = XDAY - 1.
C
  700 DO 864 I = 1,2
      DO 863 J = 1,12
      ITIML(I,J) = 0
  863 CONTINUE
  864 CONTINUE
C
      DO 13 I = 51,60
      OPTM(I) = 0
      QUITMC(I) = 480.0
   13 CONTINUE
C
      DO 23 I = 1, 50
      CC(I) = 0.
      OVRTM(I) = 0
      TRIP(I)  = 0
      WATE (I) = 0
      TOTWT (I) = 0
   23 CONTINUE
C
      DO 33 I = 1,60
      TIME(I) = 0
      EVENT(I) = 0
   33 CONTINUE
      ACRE = 0
      CLKTM = 0
      COLTMZ = 0
      CMPTMZ = 0
      FINDAY = 0.
      JOVRTM = 0
      K3 = 0.
      OCVRTM = 0
      OVRTMZ = 0
      QTM = 0
      STATQ = 0
      TTT = 0
      TTT2 =0
      WT = 0
      RETURN
      END


$IBFTC PACK.
      SUBROUTINE PACK(IWORD,I1,I2)
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRSTA,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
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```
C     COMMON AND DIMENSION FOR SIMULATION                               0130 PAK
C                                                                       0140 PAK
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0150 PAK
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0160 PAK
     2            COLFRF,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0170 PAK
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0180 PAK
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0190 PAK
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0200 PAK
     6            DOLTS,DRDPAY,DRDVRT,DSLC,DW,EVENT,FINDAY,             0210 PAK
     7            FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,             0220 PAK
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0230 PAK
     9            HISC42,HISC43,HISC44                                  0240 PAK
      COMMON /BD/ HISTO1,HISTU1,HISTU2,HISTU3,HISTU4,                   0250 PAK
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0260 PAK
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0270 PAK
     3            KINTRL,KSTMFS,KTMOP,MAXLQ,NA,NAREA,NC,NDA,            0280 PAK
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0290 PAK
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0300 PAK
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0310 PAK
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0320 PAK
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0330 PAK
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0340 PAK
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,           0350 PAK
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0360 PAK
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,              0370 PAK
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0380 PAK
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0390 PAK
     5            TREFHR,TREFML,TREFMZ,TRIP,TRKDAY,TRKLD,TRL,           0400 PAK
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0410 PAK
     7            TSLHPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0420 PAK
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,              0430 PAK
     9            WATEZ,WT,XDAY,YRS                                     0440 PAK
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0450 PAK
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,         0460 PAK
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,          0470 PAK
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0480 PAK
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0490 PAK
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0500 PAK
     6           HISC42(16),HISC43(16),HISC44(16),HISTO1(16),           0510 PAK
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0520 PAK
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,        0530 PAK
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0540 PAK
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0550 PAK
     1           TRKLD(50) ,TRL(60)     ,TSTM(1000),WATE(50) ,          0560 PAK
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0570 PAK
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0580 PAK
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0590 PAK
C                                                                       0600 PAK
      IWORD=I1*MAXINT+I2                                                0610 PAK
      RETURN                                                            0620 PAK
      END                                                               0630 PAK


$IBFTC PAN.
      SUBROUTINE PANIC                                                  0010 PAN
C                                                                       0020 PAN
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0030 PAN
C                                                                       0040 PAN
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0050 PAN
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0060 PAN
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0070 PAN
      DIMENSION ICORE(1000), CORE(50)                                   0080 PAN
      EQUIVALENCE(ICORE,CORE)                                           0090 PAN
C                                                                       0100 PAN
C                                                                       0110 PAN
C     COMMON AND DIMENSION FOR SIMULATION                               0120 PAN
C                                                                       0130 PAN
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0140 PAN
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0150 PAN
     2            COLFRF,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0160 PAN
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0170 PAN
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0180 PAN
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0190 PAN
     6            DOLTS,DRDPAY,DRDVRT,DSLC,DW,EVENT,FINDAY,             0200 PAN
     7            FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,             0210 PAN
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0220 PAN
     9            HISC42,HISC43,HISC44                                  0230 PAN
      COMMON /BD/ HISTO1,HISTU1,HISTU2,HISTU3,HISTU4,                   0240 PAN
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0250 PAN
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0260 PAN
     3            KINTRL,KSTMFS,KTMOP,MAXLQ,NA,NAREA,NC,NDA,            0270 PAN
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0280 PAN
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0290 PAN
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0300 PAN
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0310 PAN
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0320 PAN
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0330 PAN
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,           0340 PAN
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0350 PAN
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,              0360 PAN
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0370 PAN
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0380 PAN
     5           TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,            0400 PAN
     6           TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0410 PAN
     7           TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0420 PAN
     8           VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,              0430 PAN
     9           WATEZ,WT,XDAY,YRS                                     0440 PAN
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),          0450 PAN
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,        0460 PAN
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,         0470 PAN
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),         0480 PAN
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),          0490 PAN
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),          0500 PAN
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),          0510 PAN
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),          0520 PAN
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,       0530 PAN
     9            QUITMC(60),QUIT2(300),ROADIS(25),STAT(90)            0540 PAN
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0550 PAN
     1           TRKLD(50) ,TRL(60)     ,TSTM(1000),WATF(50) ,         0560 PAN
     2           DAYS(2,3), ITIME(2,12), QUITIM(50,6), RKAA(4,2),      0570 PAN
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),       0580 PAN
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)               0590 PAN
C                                                                      0600 PAN
      WRITE(IOU,100)                                                   0610 PAN
      WRITE (IOU,200) NT,ITIME2,ITYPE2                                 0620 PAN
      STOP                                                             0630 PAN
  100 FORMAT (1H-,25HPANIC SUBROUTINE ENTERED.)                        0640 PAN
  200 FORMAT (1H-,16HFOR TRUCK NUMBER,I3, 8H TIME = ,I7, 9H EVENT = ,I2)0650 PAN
      END                                                              0660 PAN


$IBFTC RAND*                                                           0010 RND
      SUBROUTINE RANDOM(MEAN,SIGMA,X)                                  0020 RND
      REAL MEAN                                                        0030 RND
      CALL BINORM(X,Y,0.)                                              0040 RND
      X=MEAN+SIGMA*X                                                   0050 RND
      RETURN                                                           0060 RND
      END                                                              0070 RND


$IBFTC RMF*                                                            0010 RMF
      SUBROUTINE REMEST(IGNO,IP,IGWN)                                  0020 RMF
C                                                                      0030 RMF
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                0040 RMF
C                                                                      0050 RMF
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2      0060 RMF
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK     0070 RMF
      COMMON MAXCPT,MAXINT,MAXT,ITYPE1                                 0080 RMF
      DIMENSION ICORE(1000), CORE(50)                                  0090 RMF
      EQUIVALENCE(ICORE,CORE)                                          0100 RMF
C                                                                      0110 RMF
C                                                                      0120 RMF
C     COMMON AND DIMENSION FOR SIMULATION                              0130 RMF
C                                                                      0140 RMF
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,          0150 RMF
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,    0160 RMF
     2            COLFRF,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,         0170 RMF
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,            0180 RMF
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,    0190 RMF
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,           0200 RMF
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,            0210 RMF
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,            0220 RMF
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,           0230 RMF
     9            HISC42,HISC43,HISC44                                 0240 RMF
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                  0250 RMF
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIME,JDW,JTRC,          0260 RMF
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,          0270 RMF
     3            KINTRL,KSTMES,KTMUP,MAXLU,NA,NAREA,NC,NDA,           0280 RMF
     4            NDR,NN,NORUT,NDELTS,NOTRC,NOTRC2,NOTRK,              0290 RMF
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,             0300 RMF
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,         0310 RMF
     7            PROFIT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,            0320 RMF
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,             0330 RMF
     9            QUITMC,QUITTM,QUIT2,R,RGVMAX,RGVMIN,RIGKA            0340 RMF
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,          0350 RMF
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLMI,SMWRKT,        0360 RMF
     2            SRIGMI,STAT,STMEST,STREML,SUMRUT,SUMTRK,             0370 RMF
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,               0380 RMF
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,          0390 RMF
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,            0400 RMF
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,              0410 RMF
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,              0420 RMF
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,             0430 RMF
     9            WATEZ,WT,XDAY,YRS                                    0440 RMF
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),          0450 RMF
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,        0460 RMF
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,         0470 RMF
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),         0480 RMF
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),          0490 RMF
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),          0500 RMF
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),          0510 RMF
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),          0520 RMF
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,       0530 RMF
     9          QUITMC(60),QUT2(300),ROADIS(25),STAT(90)                  0540 RMF
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) , 0550 RMF
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,             0560 RMF
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),         0570 RMF
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),          0580 RMF
     4           TIMEQ(2,12), INETYP(50,3), TNOHUN(50,3)                  0590 RMF
C                                                                         0590 RMF
      CALL UNPACK(IOWN,IFIRST,LAST)                                       0600 RMF
      IONC = IFIRST                                                       0610 RMF
      IF(IONC) 150,150,151                                                0620 RMF
  150 RETURN                                                              0630 RMF
  151 IXX=IONC+IP                                                         0640 RMF
      CALL UNPACK(ICORE( IXX    ),JP,IFIRST)                              0650 RMF
      ICORE( IXX    ) = -1                                                0660 RMF
      IF(IFIRST) 156,156,159                                              0670 RMF
  156 IOWN=0                                                              0680 RMF
      GO TO 150                                                           0690 RMF
  159 CALL PACK(IOWN,IFIRST,LAST)                                         0700 RMF
      IXX=IFIRST+IP                                                       0710 RMF
      CALL UNPACK(ICORE( IXX      ),JP,JS)                                0720 RMF
      CALL PACK(ICORE( IXX      ),0,JS)                                   0730 RMF
      GO TO 150                                                           0740 RMF
      END                                                                 0750 RMF
                                                                          0760 RMF


$IBFTC REML.
      SUBROUTINE REMLST(IONC,IP,IOWN)                                     0010 RML
C                                                                         0020 RML
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                   0030 RML
C                                                                         0040 RML
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2         0050 RML
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK        0060 RML
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                    0070 RML
      DIMENSION ICORE(1000), CORE(50)                                     0080 RML
      EQUIVALENCE(ICORE,CORE)                                             0090 RML
C                                                                         0100 RML
C                                                                         0110 RML
C     COMMON AND DIMENSION FOR SIMULATION                                 0120 RML
C                                                                         0130 RML
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,             0140 RML
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,       0150 RML
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,            0160 RML
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,               0170 RML
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,       0180 RML
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,              0190 RML
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,               0200 RML
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,               0210 RML
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,              0220 RML
     9            HISC42,HISC43,HISC44                                    0230 RML
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                     0240 RML
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,             0250 RML
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,             0260 RML
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,              0270 RML
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,                 0280 RML
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,                0290 RML
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNOMU,PNOSIG,            0300 RML
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,               0310 RML
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,                0320 RML
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA                0330 RML
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,             0340 RML
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,           0350 RML
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,                0360 RML
     3            TAREA,THALDS,TIME,TIMEQ,INETYP,TNOHUN,                  0370 RML
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,             0380 RML
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,               0390 RML
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                 0400 RML
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,                 0410 RML
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,                0420 RML
     9            WATEZ,WT,XDAY,YRS                                       0430 RML
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),             0440 RML
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,             0450 RML
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,             0460 RML
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),            0470 RML
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),             0480 RML
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),             0490 RML
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),             0500 RML
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),             0510 RML
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,             0520 RML
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)                0530 RML
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) , 0540 RML
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,             0550 RML
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),         0560 RML
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),          0570 RML
     4           TIMEQ(2,12), INETYP(50,3), TNOHUN(50,3)                  0580 RML
C                                                                         0590 RML
      CALL UNPACK(IOWN,IFIRST,LAST)                                       0600 RML
      ICNO=LAST                                                           0610 RML
      IF(IONC) 200,200,201                                                0620 RML
  200 RETURN                                                              0630 RML
  201 IXX=IONC+IP                                                         0640 RML
      CALL UNPACK(ICORE( IXX    ),LAST,JS)                                0650 RML
      ICORE( IXX    )=-1                                                  0660 RML
                                                                          0670 RML
      IF(LAST)205,205,206
  205 IOWN=0
      GO TO 200
  206 CALL PACK(IOWN,IFIRST,LAST)
      IXX=LAST+IP
      CALL UNPACK(ICORE( IXX   ),JP,JS)
      CALL PACK(ICORE( IXX   ),JP,0)
      GO TO 200
      END


$IBFTC REMO.
      SUBROUTINE REMOVE(IDNO,IP,IOWN)
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IPOG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRSTH,IOVRDU,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXI,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /ZOO/ A9,ACRE,AHALOS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLERE,COLMR,COLMLK,COLTMZ,COMPAP,CONA,CONB,
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,
     4            CREWTS,CRUSZ,CSPRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON /ZPO/ HISTO1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSTMES,KTMOP,MAXLQ,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PROFIT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            QII,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /ZDO/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,
     3            TAREA,THALOS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMOR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATEZ,WT,XDAY,YRS
      DIMENSION  AHALOS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)    ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTO1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALOS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
      CALL IDCHEK(IDNO)
      CALL UNPACK(IOWN,IFIRST,LAST)
      IF(IDNO-IFIRST) 100,101,100
  101 CALL REMFST(IDNO,IP,IOWN)
  102 RETURN
  100 IF(IDNO-LAST) 103,104,103
  104 CALL REMLST(IDNO,IP,IOWN)
      GO TO 102
  103 IXX=IDNO+IP
      IF(ICORE( IXX   )) 106,105,105
  107 FORMAT(///1X,12HAT ICLOCK =,I8,13HAND JCHECK = ,I8/1X,
     X52HAN ATTEMPT WAS MADE TO REMOVE IDENTIFICATION NUMBER,I8/1X,
     Y49HFROM A LIST. EITHER IT WAS NOT ON THE LIST, OR IP/1X,
     Z25HWAS INCORRECTLY SPECIFIED)
  106 WRITE(IOU,107) ICLOCK,JCHECK,IDNO
      ICHECK=5
      GO TO 102
  105 IXX=IDNO+IP
      CALL UNPACK(ICORE( IXX   ),IPRD,ISUC)
      IXX=IPRD+IP
      CALL UNPACK(ICORE( IXX   ),JP,JS)
      CALL PACK(ICORE( IXX   ),JP,ISUC)                                 0820 RMO
      IXX=ISUC+IP                                                       0830 RMO
      CALL UNPACK(ICORE( IXX   ),JP,JS)                                 0840 RMO
      CALL PACK(ICORE( IXX   ),IPRO,JS)                                 0850 RMO
      IXX=IONE+IP                                                       0860 RMO
      ICORE( IXX   )= 1                                                 0870 RMO
      GO TO 102                                                         0880 RMO
      END                                                               0890 RMO


$IBFTC RPER*                                                            0010 RPR
      SUBROUTINE RANPER(L,N)                                            0020 RPR
C         UNIFORM RANDOM PERMUTATION OF FIRST N INTEGERS                0030 RPR
      DIMENSION L(1)                                                    0040 RPR
      DO 8 I=1,N                                                        0050 RPR
    8 L(I)=I                                                            0060 RPR
      DO 20 I=1,N                                                       0070 RPR
      NN=N-I+1                                                          0080 RPR
      J=FLOAT(NN)*RNNR(0)+FLOAT(I)                                      0090 RPR
      K=L(I)                                                            0100 RPR
      L(I)=L(J)                                                         0110 RPR
   20 L(J)=K                                                            0120 RPR
      RETURN                                                            0130 RPR
      END                                                               0140 RPR


$IBFTC RIGB*                                                            0010 RGB
       SUBROUTINE RIGBAK                                                0020 RGB
C                                                                       0030 RGB
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                  0040 RGB
C                                                                       0050 RGB
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0060 RGB
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0070 RGB
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0080 RGB
      DIMENSION ICORE(1000), CORE(50)                                   0090 RGB
      EQUIVALENCE(ICORE,CORE)                                           0100 RGB
C                                                                       0110 RGB
C     COMMON AND DIMENSION FOR SIMULATION                               0120 RGB
C                                                                       0130 RGB
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0140 RGB
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0150 RGB
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0160 RGB
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0170 RGB
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DFLDEP,DMTAVE,     0180 RGB
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0190 RGB
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0200 RGB
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,             0210 RGB
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0220 RGB
     9            HISC42,HISC43,HISC44                                  0230 RGB
       COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                  0240 RGB
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0250 RGB
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0260 RGB
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,            0270 RGB
     4            NOR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0280 RGB
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0290 RGB
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0300 RGB
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0310 RGB
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0320 RGB
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0330 RGB
       COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,          0340 RGB
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0350 RGB
     2            SRIGMI,STAT,STMFST,STRFML,SUMRUT,SUMTRK,              0360 RGB
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0370 RGB
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0380 RGB
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,             0390 RGB
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0400 RGB
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0410 RGB
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,              0420 RGB
     9            WATFZ,WT,XDAY,YRS                                     0430 RGB
       DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),          0440 RGB
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,         0450 RGB
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,          0460 RGB
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0470 RGB
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0480 RGB
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0490 RGB
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),           0500 RGB
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0510 RGB
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)     ,          0520 RGB
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0530 RGB
       DIMENSION  TIML(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0540 RGB
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,           0550 RGB
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0560 RGB
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0570 RGB
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0580 RGB
C                                                                       0590 RGB
       DIMENSION TOT(60,6)                                              0600 RGB
       IF(XYXZ.EQ.-248.)GO TO 201                                       0610 RGB
       XYXZ = -248                                                      0620 RGB
C                                                                       0630 RGB
       DO 210 I = 1,60                                                  0640 RGB
       DO 211 J = 1,6                                                   0650 RGB
       TOT(I,J) = 0.0                                                   0660 RGB
```

```
  211 CONTINUE                                                           0670 RGB
  210 CONTINUE                                                           0680 RGB
C                                                                        0690 RGB
  201 FINDAY = 0.                                                        0700 RGB
      IF(JDW.NE.1) GO TO 8                                               0710 RGB
    8 KBAK = TIME(NT) + .5                                               0720 RGB
      JTRC=TRC(NT)+.5                                                    0730 RGB
      STAT(JTRC) = 8                                                     0740 RGB
      JTRL=TRL(NT)+.5                                                    0750 RGB
      STAT(JTRL) = 10                                                    0760 RGB
      QUITMC(JTRC) = KBAK                                                0770 RGB
      X101 = QUITMC(JTRC) - QH                                           0780 RGB
      X111 = X101/60.                                                    0790 RGB
      IF(X101.LE.480.) GO TO 100                                         0800 RGB
C     WRITE(IOU,110) JTRC,X111                                           0810 RGB
  110 FORMAT(1H ,7HTRACTOR,I6,29H IS ON OVERTIME HAVING WORKED,F8.2,     0820 RGB
     1 6H HOURS)                                                         0830 RGB
      X111 = X111 - 8.0                                                  0840 RGB
      M3 = X111 + 1.0                                                    0850 RGB
      IF(M3.GT.3) M3 = 3                                                 0860 RGB
      YM3 = M3                                                           0870 RGB
      IF(YM3.EQ.TOT(JTRC,JDW)) GO TO 100                                 0880 RGB
      IF (M3.GT.2) GO TO 803                                             0890 RGB
      GO TO (801,802), M3                                                0900 RGB
  801 TOT(JTRC,JDW) = 1.                                                 0910 RGB
      B(1) = B(1) + 1.                                                   0920 RGB
      GO TO 100                                                          0930 RGB
  802 IF(TOT(JTRC,JDW).EQ.1.) GO TO 220                                  0940 RGB
      TOT(JTRC,JDW) = 2.                                                 0950 RGB
      B(2) = B(2) + 1.                                                   0960 RGB
      GO TO 100                                                          0970 RGB
  220 B(1) = B(1) - 1.                                                   0980 RGB
      TOT (JTRC,JDW) = 2.                                                0990 RGB
      B(2) = B(2) + 1.                                                   1000 RGB
      GO TO 100                                                          1010 RGB
  803 IF (TOT(JTRC,JDW).EQ.1.) GO TO 230                                 1020 RGB
      IF (TOT(JTRC,JDW).EQ.2.) GO TO 240                                 1030 RGB
  231 TOT(JTRC,JDW) = 3.                                                 1040 RGB
      B(3) = B(3) + 1.                                                   1050 RGB
      GO TO 100                                                          1060 RGB
  230  B(1) = B(1) - 1.                                                  1070 RGB
      GO TO 231                                                          1080 RGB
  240 B(2) = B(2) - 1.                                                   1090 RGB
      GO TO 231                                                          1100 RGB
C                                                                        1110 RGB
  100 DO 10 I = 71,90                                                    1120 RGB
      IF(STAT(I).EQ.12.) GO TO 20                                        1130 RGB
   10 CONTINUE                                                           1140 RGB
C                                                                        1150 RGB
      GO TO 50                                                           1160 RGB
C                                                                        1170 RGB
   20 DO 35 J = 51, NOTRC2                                               1180 RGB
      IF(STAT(J).EQ.8.) GO TO 30                                         1190 RGB
   35 CONTINUE                                                           1200 RGB
C                                                                        1210 RGB
      GO TO 50                                                           1220 RGB
C                                                                        1230 RGB
   30 NT = J                                                             1240 RGB
      EVENT(NT) = 7                                                      1250 RGB
      TIME(NT) = KBAK + 10                                               1260 RGB
      TRL(NT) = I                                                        1270 RGB
      TRC(NT) = J                                                        1280 RGB
      STAT(NT) = 9                                                       1290 RGB
      STAT (I) = 11                                                      1300 RGB
      GO TO 99                                                           1310 RGB
   50 FINDAY=99.                                                         1320 RGB
   99 RETURN                                                             1330 RGB
      END                                                                1340 RGB


$IBFTC RIGO*                                                             0010 RGO
         SUBROUTINE RIGOUT                                               0020 RGO
C                                                                        0030 RGO
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                  0040 RGO
C                                                                        0050 RGO
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2        0060 RGO
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK       0070 RGO
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                   0080 RGO
      DIMENSION ICORE(1000), CORE(50)                                    0090 RGO
      EQUIVALENCE(ICORE,CORE)                                            0100 RGO
C                                                                        0110 RGO
C                                                                        0120 RGO
C     COMMON AND DIMENSION FOR SIMULATION                                0130 RGO
C                                                                        0140 RGO
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,            0150 RGO
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,      0160 RGO
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,           0170 RGO
     3            CONC,COND,CONE,CON ,COSCOL,CORACR,COSLND,              0180 RGO
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,      0190 RGO
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,             0200 RGO
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,              0210 RGO
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,              0220 RGO
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,                   0230 RGO
     9             HISC42,HISC43,HISC44                                         0240 RGO
      COMMON /RG2/ HISTO1,HISTU1,HISTU2,HISTU3,HISTU4,                          0250 RGO
     1             ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JOW,JTRC,                  0260 RGO
     2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPIS,KINTRK,                  0270 RGO
     3             KINTRL,KSTMES,KTMOP,MAXLG,NA,NAREA,NC,NDA,                   0280 RGO
     4             NCR,NN,NORUT,NOELTS,NOTRC,NOTRC2,NOTRK,                      0290 RGO
     5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,                     0300 RGO
     6             ORDR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,                 0310 RGO
     7             PRRELT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,                    0320 RGO
     8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,                     0330 RGO
     9             QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA                     0340 RGO
      COMMON /RG3/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,                  0350 RGO
     1             ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,                0360 RGO
     2             SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,                     0370 RGO
     3             TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                       0380 RGO
     4             TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,                  0390 RGO
     5             TREOR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,                    0400 RGO
     6             TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                      0410 RGO
     7             TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,                      0420 RGO
     8             VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,                     0430 RGO
     9             WATEZ,WT,XDAY,YRS                                            0440 RGO
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),                   0450 RGO
     1           ASNOPT(25),AAS3UN(25),AX1(25)    ,AX2(25)    ,                 0460 RGO
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,                  0470 RGO
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,MISC12(16),                  0480 RGO
     4           MISC13(16),MISC14(16),MISC22(16),MISC23(16),                   0490 RGO
     5           MISC24(16),MISC32(16),MISC33(16),MISC34(16),                   0500 RGO
     6           MISC42(16),MISC43(16),MISC44(16),MISTO1(16),                   0510 RGO
     7           MISTU1(16),MISTU2(16),MISTU3(16),MISTU4(16),                   0520 RGO
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)      ,               0530 RGO
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)                      0540 RGO
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,       0550 RGO
     1           TRKLD(50) ,TRL(60)     ,TSTM(1000),WATE(50) ,                  0560 RGO
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),               0570 RGO
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),                0580 RGO
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                        0590 RGO
C                                                                               0600 RGO
    9 TRPRIG = TRPRIG + 1.                                                      0610 RGO
      JTRL = TRL(NT)                                                            0620 RGO
      JTRC = TRC(NT)                                                            0630 RGO
      TRIP(JTRL) = TRIP(JTRL) + 1.                                              0640 RGO
      CALL RANCCM(ONCE,TRES,ROPTM)                                              0650 RGO
      IF (TRLHAL.GT.RMXDSR) GO TO 864                                           0660 RGO
      VELMU = RIGKA + (RIGKB * TRLHAL)                                          0670 RGO
      GO TO 866                                                                 0680 RGO
  864 VELMU = VELMUR                                                            0690 RGO
  866 CALL RANLCM(VELMU,VELSGR,RGLOG1)                                          0700 RGO
      CALL RANLCM (VELMU,VELSGR,RGLOG2)                                         0710 RGO
      RGVL1 = 10.**RGLOG1                                                       0720 RGO
      IF (RGVL1.GT.RGVMIN) GO TO 401                                            0730 RGO
      RGVL1 = RGVMIN                                                            0740 RGO
      GO TO 307                                                                 0750 RGO
  401 IF (RGVL1.LT.RGVMAX) GO TO 307                                            0760 RGO
      RGVL1 = RGVMAX                                                            0770 RGO
  307 RGVL2 = 10.**RGLOG2                                                       0780 RGO
      IF (RGVL2.GT.RGVMIN) GO TO 501                                            0790 RGO
      RGVL2 = RGVMIN                                                            0800 RGO
      GO TO 407                                                                 0810 RGO
  501 IF (RGVL2 .LT.RGVMAX) GO TO 407                                           0820 RGO
      RGVL2 = RGVMAX                                                            0830 RGO
  407 TMGONE = ROPTM + (TRLHAL*60./RGVL1) +(TRLHAL*60./RGVL2)                   0840 RGO
      EVENT (NT) = 8                                                            0850 RGO
      TIME(NT) = TIME(NT) + TMGONE                                              0860 RGO
      TRL(NT) = JTRL                                                            0870 RGO
      TRC(NT) = JTRC                                                            0880 RGO
      OPTM(JTRC) = OPTM(JTRC) + TMGONE                                          0890 RGO
      TRIP(NT) = TRIP(NT) + 1.                                                  0900 RGO
      RETURN                                                                    0910 RGO
      END                                                                       0920 RGO


$IBFTC RNNR.                                                                    RNNR 000
      FUNCTION RNNR(K)                                                          RNNR 010
      IF(KK.EQ.-123456) GO TO 10                                                RNNR 020
      KK=-123456                                                                RNNR 030
      K1=K                                                                      RNNR 040
      IF(K1.EQ.0) K1=5**15                                                      RNNR 050
      M35=34359738367                                                           RNNR 060
      X35=M35                                                                   RNNR 070
   10 K1=K1*183467                                                              RNNR 080
      K1=K1-(K1/M35)*M35                                                        RNNR 090
      X=K1                                                                      RNNR 100
      RNNR=X/X35                                                                RNNR 110
      RETURN                                                                    RNNR 120
      END                                                                       RNNR 130


$IBFTC RUNDT.                                                                   0010RUND
       SUBROUTINE RUNDAT                                                        0020RUND
C                                                                               0030RUND
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C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALOR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRI,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /ROD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2             COLFRE,COLHR,COLMLK,COLTM2,COMPAP,CONA,CONB,
     3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSEND,
     4             CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6             DOLTS,DROPAY,DROVRT,ESLC,DW,EVENT,FINDAY,
     7             FLATND,FLTITM,FX,FY,HISC12,HISC13,HISC14,
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9             HISC42,HISC43,HISC44
      COMMON /ROD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1             ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIME,JDW,JTRC,
     2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3             KINTRL,KSTMTS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,
     4             NDR,NN,NORUT,NOELTS,NOTRC,NOTRC2,NOTRK,
     5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6             ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7             PRHELT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9             QUITMC,QUITIM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /ROD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1             ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2             SRIGML,STAT,SIMEST,STREML,SUMRUT,SUMTRK,
     3             TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4             TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5             TREHR,TREML,TRETM2,TRIP,TRKDAY,TRKLD,TRL,
     6             TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7             TSLHPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8             VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9             WATE2,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)    ,
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)     ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ITIME(2,12), QUITIM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
      READ(IN,666) COLFRE,ASSSUN,ASSUNK,TRLHAL,RUNNO,K,NOTRC,Q9,Q10
  666 FORMAT(5F5.1,2I5,2F5.1)
      WRITE(IOU,666) COLFRE,ASSSUN,ASSUNK,TRLHAL,RUNNO,K,NOTRC,Q9,Q10
      NOTRC2 = NOTRC + 50
      NER = 6./COLFRE
      IF (NOTRC.NE.0) GO TO 217
  201 IF(COLFRE.EQ.2.) GO TO 204
  202 DAYSLC = 3.
  203 GO TO 205
  204 DAYSLC = 4.
  205 S6S = 0.
  206 DO 208 I = 1,NAREA
  207 S6S = S6S + ANOHUN(I)
  208 CONTINUE
      AVEPOP = (PERUN(1) +PERUN(2) +PERUN(3) + PERUN(4)) / 4.
  209 ZNNNN = S6S * PNDMU * DAYSLC * AVEPOP * COLFRE * 10.
      NOTRC = ZNNNN / (6.*RIGMAX*(69.-TRLHAL))
  211 IF(NOTRC.LT.2) NOTRC = 2
  212 IF (NOTRC.GT.10) GO TO 214
  213 GO TO 217
  214 WRITE (IOU,215)
  215 FORMAT(1H ,67HMORE THAN 10 TRACTORS NEEDED, AREA BEING SIMULATED M
     1UST BE SMALLER.)
      STOP
  217 NOTRC2 = NOTRC + 50
      IRUNNO = RUNNO
      JSN = ASSSUN + 1.
      GO TO (10,11,11), JSN
   10 RIGMAX = 9999999
   11 RETURN
      END
```

```
$IBFTC STAC.
      SUBROUTINE STAC(N1,N2,X,MEAN,SIG,MAX,MIN)
      DIMENSION X(1)
      REAL MEAN,MAX,MIN
      NM1=N2-N1
      NT=NM1+1
      XN=NT
      MAX=X(N1)
      MIN=X(N1)
      MEAN=0.
      VAR=0.
      DO 10 I = N1,N2
      IF(X(I).LE.MAX) GO TO 5
      MAX=X(I)
      GO TO 9
    5 IF(X(I).GE.MIN) GO TO 9
      MIN=X(I)
    9 MEAN=MEAN+X(I)
      VAR=VAR+X(I)*X(I)
   10 CONTINUE
      MEAN=MEAN/XN
      SIG=SQRT(VAR/XN - MEAN*MEAN)
      RETURN
      END


$IBFTC TABL.
      SUBROUTINE TABL
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALOR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7            FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCUS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLRPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATEZ,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4)  ,
     3           CORACR(4)  ,CTS(6)      ,EVENT(60)  ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)   ,OVRTM(50)  ,PERUN(4)   ,QQ(50)     ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)   ,TONAGE(6)  ,TOTWT(50)  ,TRC(60)    ,TRIP(90) ,
     1           TRKLD(50)  ,TRL(60)    ,TSTM(1000),WATE(50)  ,
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
C
      DO 100 I = 1,NAREA
      IF(Q10.EQ.0.) GO TO 10
      AHALDS(I)=(ABS(AX1(I)-AX2(I))+ABS(AY1(I)-AY2(I))+ROADIS(I))
     1      /  5280.
      X = AHALDS(I)
      IF(X.GT.1.25)GO TO 21
      X = 1.25                                                          0670 TB1
      GO TO 21                                                          0680 TB1
   10 AHALDS(I) = TRLHAL                                                0690 TB1
      X = AHALDS(I)                                                     0700 TB1
   21 NN = ANETYP(I)                                                    0710 TB1
      NC = COLFRE  - 1.                                                 0720 TB1
      AASSUN(I) =RKAA(NN,NC) + (RKBB(NN,NC)*X) +(RKCC(NN,NC)*X*X)       0730 TB1
      AASSUN(I) = ASSUNK * AASSUN(I)                                    0740 TB1
      ANORUT(I) =       ANOHUN(I)/AASSUN(I)                             0750 TB1
      NCRUT = ANORUT(I) + 0.75                                          0760 TB1
   60 ANORUT(I) = NORUT                                                 0770 TB1
      ASNUPT(I) = ANOHUN(I)/ANORUT(I)                                   0780 TB1
      Y =ASNUPT(I)                                                      0790 TB1
      IF (Y.LT.1400.) GO TO 100                                         0800 TB1
      NCRUT = NORUT + 1                                                 0810 TB1
      GO TO 60                                                          0820 TB1
  100 CONTINUE                                                          0830 TB1
C                                                                       0840 TB1
      RETURN                                                            0850 TB1
      END                                                               0860 TB1


$IBFTC TAB2*                                                            0010 TB2
       SUBROUTINE TABL2                                                 0020 TB2
C                                                                       0030 TB2
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0040 TB2
C                                                                       0050 TB2
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0060 TB2
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0070 TB2
      COMMON MAXCHF,MAXINT,MAXT,ITYPE1                                  0080 TB2
      DIMENSION ICORE(1000), CORE(50)                                   0090 TB2
      EQUIVALENCE(ICORE,CORE)                                           0100 TB2
C                                                                       0110 TB2
C                                                                       0120 TB2
C     COMMON AND DIMENSION FOR SIMULATION                               0130 TB2
C                                                                       0140 TB2
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0150 TB2
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0160 TB2
     2            COLFRE,COLHR,COLMLK,COLTM2,COMPAP,CONA,CONB,          0170 TB2
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSEND,             0180 TB2
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DFLDEP,DMTAVE,     0190 TB2
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0200 TB2
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0210 TB2
     7            FLAINO,FLTLTM,FX,FY,MISC12,MISC13,MISC14,             0220 TB2
     8            MISC22,MISC23,MISC24,MISC32,MISC33,MISC34,            0230 TB2
     9            MISC42,MISC43,MISC44                                  0240 TB2
      COMMON /BD/ MISTD1,MISTU1,MISTU2,MISTU3,MISTU4,                   0250 TB2
     1            ICOLER,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0260 TB2
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0270 TB2
     3            KINTRL,LSTMES,KTMOP,MAXLQ,NA,NAREA,NC,NDA,            0280 TB2
     4            NCR,NN,NCRUT,NOELTS,NOTRC,NOTRC2,NOTRK,               0290 TB2
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0300 TB2
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0310 TB2
     7            PRAFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0320 TB2
     8            Q11,QMAX,QQ,QUIAVF,QUIMAX,QUIMIN,QUISIG,              0330 TB2
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0340 TB2
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,           0350 TB2
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0360 TB2
     2            SRIGML,STAT,STMEST,STRFML,SUMRUT,SUMTRK,              0370 TB2
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0380 TB2
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0390 TB2
     5            TREHR,TREML,TRETM2,TRIP,TRKDAY,TRKLD,TRL,             0400 TB2
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0410 TB2
     7            TSLHPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0420 TB2
     8            VELMIN,VELMUN,VELMUT,VELSGR,VELSGT,WATE,              0430 TB2
     9            WATE2,WT,XDAY,YRS                                     0440 TB2
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0450 TB2
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,           0460 TB2
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,           0470 TB2
     3           CORACR(4) ,CTS(6)    ,EVENT(60) ,MISC12(16),           0480 TB2
     4           MISC13(16),MISC14(16),MISC22(16),MISC23(16),           0490 TB2
     5           MISC24(16),MISC32(16),MISC33(16),MISC34(16),           0500 TB2
     6           MISC42(16),MISC43(16),MISC44(16),MISTD1(16),           0510 TB2
     7           MISTU1(16),MISTU2(16),MISTU3(16),MISTU4(16),           0520 TB2
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,           0530 TB2
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0540 TB2
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) , 0550 TB2
     1           TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,            0560 TB2
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0570 TB2
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0580 TB2
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0590 TB2
C                                                                       0600 TB2
C                                                                       0610 TB2
      DO 10 I = 1,NAREA                                                 0620 TB2
      SUMRUT = SUMRUT + ANORUT(I)                                       0630 TB2
   10 CONTINUE                                                          0640 TB2
C                                                                       0650 TB2
      TRKDAY = SUMRUT * COLFRE                                          0660 TB2
      NCTRK = (TRKDAY/6. + 0.99)                                        0670 TB2
      XDAY = NCTRK                                                      0680 TB2
      IF(NOTRK.GT.50) GO TO 210                                         0690 TB2
      GO TO 11                                                          0700 TB2
  210 WRITE(IOU,12)                                                     0710 TB2
   12 FORMAT(1H ,65HMORE THAN 50 TRUCKS NEEDED, AREA BEING SIMULATED MUS0720 TB2
     1T BE SMALLER.)                                                    0730 TB2
      STOP                                                              0740 TB2
   11 ZN = 0                                                            0750 TB2
      L=1                                                               0760 TB2
C                                                                       0770 TB2
      DO 100 I = 1,NOTRK                                                0780 TB2
      DO 200 J = 1,NOR                                                  0790 TB2
      TAREA(I,J) = L                                                    0800 TB2
      TRALDS(I,J) = AHALDS(L)                                           0810 TB2
      TNETYP(I,J) = ANETYP(L)                                           0820 TB2
      TNOHUN(I,J) = ASNUPT(L)                                           0830 TB2
      ZN = ZN + 1.                                                      0840 TB2
      X13 = ANORUT(L)                                                   0850 TB2
      IF (ZN.NE.X13) GO TO 200                                          0860 TB2
      ZN = 0.                                                           0870 TB2
      L = L + 1                                                         0880 TB2
      IF(L.LE.NAREA) GO TO 200                                          0890 TB2
      GO TO 600                                                         0900 TB2
  200 CONTINUE                                                          0910 TB2
  100 CONTINUE                                                          0920 TB2
C                                                                       0930 TB2
  600 JCOLK = COLFRE - 1.                                               0940 TB2
      GO TO (37,47),JCOLK                                               0950 TB2
   37 Z33 = 4                                                           0960 TB2
      GO TO 39                                                          0970 TB2
   47 Z33 = 3                                                           0980 TB2
   39 SUMMUN = 0                                                        0990 TB2
      DO 173 I = 1, NAREA                                               1000 TB2
      SUMMUN = SUMMUN + ANOHUN(I)                                       1010 TB2
  173 CONTINUE                                                          1020 TB2
C                                                                       1030 TB2
      AVEPOP =(PERUN(1) + PERUN(2) + PERUN(3) + PERUN(4)) / 4.          1040 TB2
      KAPTS = (SUMMUN * AVEPOP * PNDMU * Z33 * COLFRE) / 120000.        1050 TB2
      KAPTS = 10  * KAPTS                                               1060 TB2
      IF(KAPTS.LE.100) GO TO 174                                        1070 TB2
      ZKAPTS = KAPTS                                                    1080 TB2
      DOLTS =  (CONE * ZKAPTS) + CONB + COMPAP                          1090 TB2
      GO TO 185                                                         1100 TB2
  174 DOLTS = COND + COMPAP                                             1110 TB2
  185 IF(KAPTS.LE.200) GO TO 274                                        1120 TB2
      ZKA = KAPTS                                                       1130 TB2
      COSLND = CONF * ZKA                                               1140 TB2
      CREWTS = 4.                                                       1150 TB2
      GO TO 275                                                         1160 TB2
  274 COSLND = CONA                                                     1170 TB2
      CREWTS = 3.0                                                      1180 TB2
  275 DOLTS = DOLTS + COSLND                                            1190 TB2
  175 F1 = CREWTS * TSLRPA                                              1200 TB2
      F2 = COSLND * R / 300.                                            1210 TB2
      F3 = UTILTY / 25.                                                 1220 TB2
      F4 = ((DOLTS-COSLND)*R*((1.+R)**YRS)) / ((((1.+R)**YRS)-1.)*300.) 1230 TB2
      F5 = Q7/300.                                                      1240 TB2
      A9 = F1+F2+F3+F4+F5                                               1250 TB2
  217 RETURN                                                            1260 TB2
      END                                                               1270 TB2


@IMFIC TALPR.                                                           0010 TBP
       SUBROUTINE TALPRN                                                0020 TBP
C                                                                       0030 TBP
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0040 TBP
C                                                                       0050 TBP
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0060 TBP
      COMMON IFRST4,IFRSTA,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0070 TBP
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0080 TBP
      DIMENSION ICORE(1000), CORE(50)                                   0090 TBP
      EQUIVALENCE(ICORE,CORE)                                           0100 TBP
C                                                                       0110 TBP
C     COMMON AND DIMENSION FOR SIMULATION                               0120 TBP
C                                                                       0130 TBP
      COMMON /RD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0140 TBP
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0150 TBP
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0160 TBP
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0170 TBP
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0180 TBP
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0190 TBP
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0200 TBP
     7            FLATNO,FLTLIM,FX,FY,HISC12,HISC13,HISC14,             0210 TBP
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0220 TBP
     9            HISC42,HISC43,HISC44                                  0230 TBP
      COMMON /RD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                   0240 TBP
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0250 TBP
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0260 TBP
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,            0270 TBP
     4            NOR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0280 TBP
     5            NCTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0290 TBP
     6            ORHR,OVPAYL,OVRTM,PAYLRR,PERUN,PNDMU,PNOSIG,          0300 TBP
     7            PRRFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0310 TBP
     8            QII,QMAX,QO,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITME,QUITTIM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /PE/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGMI,STAT,SIMEST,STREMI,SUMRUT,SUMTRK,
     3            TAREA,THALDS,TIME,TIMEQ,INETYP,INOHUN,
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TREHR,TREMI,TREIMZ,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMOR,VELMOT,VELSGR,VELSGT,WATE,
     9            WATE2,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNOPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTO1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ETIME(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4           TIMEQ(2,12), INETYP(5C,3), INOHUN(50,3)
C
C
      DATA CON,FIN/6HCONTI,6HNUED) /
C
 8021 FORMAT(1H1/1H-/1H-/1H-/1H-,41X,44HSOLID WASTE COLLECTION SIMULATIO
     IN RUN NUMBER,I5/1H0,61X,13HMODEL   THREE/1H-/1H-)
 8022 FORMAT(1H0,45X,50HTHIS IS A SIMULATION  RUN ON A PORTION OF THE CI
     1TY/41X,55HOF BALTIMORE,  APPROXIMATELY  DESCRIBED AS  'THAT TRACT/
     241X,55HBOUNDED ON THE NORTH BY THE CITY LIMITS, ON THE EAST BY/
     341X,
     3 55HYORK AVENUE, ON THE SOUTH BY  NORTH AVENUE,  AND ON THE/41X,25
     4HWEST BY THE CITY LIMITS.')
 8023 FORMAT(1H0,45X,19HWITHIN  THIS TRACT,I4,27H RESIDENTIAL AREAS, EAC
     1H OF
     1     /41X,55HPARTICULAR HOUSING DENSITY, HAVE BEEN GIVEN NUMBER DE
     2S-/41X,20HIGNATIONS FROM 1 TO I3,32H.   TABLE ONE BELOW  LISTS THE
     3SE
     3 /41X,33HAREAS AND DATA PERTINENT TO EACH.,I3,19H COLLECTION TRUCK
     4S,
     4/41X,26HALL COMPACTER TYPE ARE OF I3,26H CUBIC YARD CAPACITY, HAVE
     5/41X,22HBEEN ASSIGNED TO THESE,I3,27H AREAS TO MAKE  COLLECTION ,
     6I3/41X, 15HTIMES PER WEEK.)
 8024 FORMAT(1H0,45X,50HTHE CREWS  ASSIGNED TO THE TRUCKS ARE A DRIVER A
     1ND/41X,26HTWO LABORERS AT ALL TIMES.)
 8025 FORMAT(1H0,45X,50HTHE CREWS  ASSIGNED TO THE TRUCKS ARE A DRIVER A
     1ND/41X,55HTHREE LABORERS ON MONDAYS, TUESDAYS AND WEDNESDAYS, AND/
     141X,55HA DRIVER AND TWO LABORERS ON THE REMAINING DAYS.        )
 8026 FORMAT(1H0,45X,50HTABLE TWO LISTS THE ASSIGNED  COLLECTION TRUCKS
     1BY
     1  /41X,41HNUMBER AND LISTS DATA PERTINENT FOR EACH.)
 8027 FORMAT(1H1/1H-/1H-/1H /1H ,59X,18H*** TABLE  ONE ***/64X,2A6)
 8127 FORMAT (1H-,
     1 40X,56HAREA    NEIGHBOR-  HOUSING   TRUCKS   ASSIGNED   NUMBER
     2/41X,56HNUMBER  HOOD TYPE  UNITS     HAUL     UNITS PER  OF
     3/41X,19X,37HTOTAL     MILES     TRUCK      ROUTES          /1H
 8028 FORMAT(1H1/1H-/1H-/1H /1H ,59X,18H*** TABLE  TWO ***/64X,2A6)
 8128 FORMAT (1H-,
     1 40X,56HTRUCK   ASSIGNED  UNITS TO   HAUL     NEIGHBOR-  DAYS TO
     2/41X,56HNUMBER  TO AREA   COLLECT  DISTANCE   HOOD TYPE  COLLECT
     3/1H )
 8030 FORMAT(1H ,40X,2X,I3,5X,I4,6X,I5,2X,F7.2,7X,I3,6X,A6)
C
C             FORMAT 8029 IS FOR TABLE 1
C             FORMAT 8030 IS FOR TABLE 2
C
 8029 FORMAT(1H ,40X,2X,I3,5X,I3,6X,I5,4X,F6.2,4X, I7, 5X,I3)
 8031 FORMAT(1H1)
C
      LINE=0
      WRITE(ICU,8021)RUNNO
      WRITE(ICU,8022)
      WRITE(ICU,8023)NAREA,NAREA,NOTRK,KINTRK,NAREA,ICOLFR
      IF(COLFMI.EQ.2.) GO TO 21
      WRITE(ICU,8024)
      GC TO 31
   21 WRITE(ICU,8025)
   31 WRITE(ICU,8026)
      LINE = 8
      WRITE(ICU,8027)
      WRITE(ICU,8127)
C
      DC 88 I = 1,NAREA
      KLETYP=ANETYP(I)
      KLOHUN=ANOHUN(I)
      KLNOPT=ASNOPT(I)
      KLORUT=ANORUT(I)                                                  1240 TBP
      WRITE(IOU,8029)I,KLETYP,KLOHUN,AHALDS(I),KLNUPT,KLORUT            1250 TBP
      LINE=LINE+1                                                       1260 TBP
      IF(LINE.LT.48) GO TO 88                                           1270 TBP
      LINE=8                                                            1280 TBP
      WRITE(IOU,8028) CON,TIN                                           1290 TBP
      WRITE(IOU,8128)                                                   1300 TBP
   88 CONTINUE                                                          1310 TBP
C                                                                       1320 TBP
      LINE=8                                                            1330 TBP
      WRITE(IOU,8028)                                                   1340 TBP
      WRITE(IOU,8128)                                                   1350 TBP
      K5 = COLFRF - 1.                                                  1360 TBP
C                                                                       1370 TBP
      DO 91 I = 1,NOTRK                                                 1380 TBP
      DO 99 J = 1, NDR                                                  1390 TBP
      JNETYP = TNETYP(I,J)                                              1400 TBP
      JAREA = TAREA(I,J)                                                1410 TBP
      KLOHUN=TNOHUN(I,J)                                                1420 TBP
      WRITE(IOU,8030) I,JAREA,KLOHUN,THALDS(I,J),JNETYP,DAYS(K5,J)      1430 TBP
      LINE=LINE+1                                                       1440 TBP
      IF(LINE.LT.48) GO TO 99                                           1450 TBP
      LINE=8                                                            1460 TBP
      WRITE(IOU,8028) CON,TIN                                           1470 TBP
      WRITE(IOU,8128)                                                   1480 TBP
   99 CONTINUE                                                          1490 TBP
   91 CONTINUE                                                          1500 TBP
C                                                                       1510 TBP
      WRITE(IOU,8031)                                                   1520 TBP
      RETURN                                                            1530 TBP
      END                                                               1540 TBP


$IBFTC TIME.                                                            0010 TIM
      SUBROUTINE TIMER                                                  0020 TIM
C                                                                       0030 TIM
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0040 TIM
C                                                                       0050 TIM
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0060 TIM
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0070 TIM
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0080 TIM
      DIMENSION ICORE(1000), CORE(50)                                   0090 TIM
      EQUIVALENCE(ICORE,CORE)                                           0100 TIM
C                                                                       0110 TIM
C                                                                       0120 TIM
C     COMMON AND DIMENSION FOR SIMULATION                               0130 TIM
C                                                                       0140 TIM
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0150 TIM
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0160 TIM
     2            COLFRF,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0170 TIM
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLDD,             0180 TIM
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0190 TIM
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0200 TIM
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0210 TIM
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,             0220 TIM
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0230 TIM
     9            HISC42,HISC43,HISC44                                  0240 TIM
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                   0250 TIM
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0260 TIM
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0270 TIM
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,            0280 TIM
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0290 TIM
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0300 TIM
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0310 TIM
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0320 TIM
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0330 TIM
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0340 TIM
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,           0350 TIM
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0360 TIM
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,              0370 TIM
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0380 TIM
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0390 TIM
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,             0400 TIM
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0410 TIM
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0420 TIM
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,              0430 TIM
     9            WATEZ,WT,XDAY,YRS                                     0440 TIM
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0450 TIM
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,         0460 TIM
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,          0470 TIM
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0480 TIM
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0490 TIM
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0500 TIM
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),           0510 TIM
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0520 TIM
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)      ,       0530 TIM
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0540 TIM
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0550 TIM
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,           0560 TIM
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0570 TIM
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0580 TIM
     4              TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0590 TIM
      JCLOCK = 0                                                           0600 TIM
 1001 CALL REMFST(IDNO,4,ICALDR)                                           0610 TIM
      ITIME1 = ICORE(IDNO+1)/10                                            0620 TIM
      ITYPE1 = ICORE(IDNO+1) - 10 * ITIME1                                 0630 TIM
      NT = ICORE(IDNO + 3)                                                 0640 TIM
 1021 ICLOCK = ITIME1                                                      0650 TIM
      JCLOCK = ICLOCK                                                      0660 TIM
      GO TO (10,20,30,40,40,60,55,65),ITYPE1                               0670 TIM
 1004 RETURN                                                               0680 TIM
   10 CALL TRAFIC                                                          0690 TIM
      GO TO 100                                                            0700 TIM
   20 CALL COLECT                                                          0710 TIM
      GO TO 100                                                            0720 TIM
   30 CALL TRAFIC                                                          0730 TIM
      GO TO 100                                                            0740 TIM
   40 CALL DISPSE(IDNO)                                                    0750 TIM
      IF(FINDAY.EQ.99.) GO TO 200                                          0760 TIM
      GO TO 100                                                            0770 TIM
   60 CONTINUE                                                             0780 TIM
   55 CALL RIGOUT                                                          0790 TIM
      GO TO 100                                                            0800 TIM
   65 CALL RIGPAK                                                          0810 TIM
      IF(FINDAY.EQ.99.) GO TO 200                                          0820 TIM
  100 ITYPE2 = EVENT(NT) + .5                                              0830 TIM
      ITIME2 = TIME(NT) + .5                                               0840 TIM
      ICORE(IDNO+3) = NT                                                   0850 TIM
      CALL CAUSE(ITYPE2,IDNO,ITIME2)                                       0860 TIM
  200 IF(ICALDR.EQ.0) GO TO 1004                                           0870 TIM
      GO TO 1001                                                           0880 TIM
      END                                                                  0890 TIM


$IBFTC TRAF.                                                               0010 TRF
       SUBROUTINE TRAFIC                                                   0020 TRF
C                                                                          0030 TRF
C      COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                   0040 TRF
C                                                                          0050 TRF
       COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2         0060 TRF
       COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK        0070 TRF
       COMMON MAXCRE,MAXINT,MAXI,ITYPE1                                    0080 TRF
       DIMENSION ICORE(1000), CORE(50)                                     0090 TRF
       EQUIVALENCE(ICORE,CORE)                                             0100 TRF
C                                                                          0110 TRF
C                                                                          0120 TRF
C      COMMON AND DIMENSION FOR SIMULATION                                 0130 TRF
C                                                                          0140 TRF
       COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,             0150 TRF
     1             AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,       0160 TRF
     2             COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,            0170 TRF
     3             CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,               0180 TRF
     4             CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,       0190 TRF
     5             DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,              0200 TRF
     6             DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,               0210 TRF
     7             FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,               0220 TRF
     8             HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,              0230 TRF
     9             HISC42,HISC43,HISC44                                    0240 TRF
       COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                     0250 TRF
     1             ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,             0260 TRF
     2             JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,             0270 TRF
     3             KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,              0280 TRF
     4             NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,                 0290 TRF
     5             NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,                0300 TRF
     6             ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,            0310 TRF
     7             PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,               0320 TRF
     8             Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,                0330 TRF
     9             QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA                0340 TRF
       COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,             0350 TRF
     1             ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,           0360 TRF
     2             SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,                0370 TRF
     3             TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                  0380 TRF
     4             TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,             0390 TRF
     5             TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,               0400 TRF
     6             TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,                 0410 TRF
     7             TSLHPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,                 0420 TRF
     8             VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,                0430 TRF
     9             WATTZ,WT,XDAY,YRS                                       0440 TRF
       DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),             0450 TRF
     1            ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,             0460 TRF
     2            AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,             0470 TRF
     3            CORACR(4) ,CTS(6)    ,EVENT(60) ,HISC12(16),             0480 TRF
     4            HISC13(16),HISC14(16),HISC22(16),HISC23(16),             0490 TRF
     5            HISC24(16),HISC32(16),HISC33(16),HISC34(16),             0500 TRF
     6            HISC42(16),HISC43(16),HISC44(16),HISTD1(16),             0510 TRF
     7            HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),             0520 TRF
     8            OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,             0530 TRF
     9             QUITMC(60),QUT2(300),ROADIS(25),STAT(90)                0540 TRF
       DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) ,   0550 TRF
     1            TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50)  ,             0560 TRF
     2            DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),         0570 TRF
     3            RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),          0580 TRF
     4            TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                  0590 TRF
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```
C
C                                                                       0600 TRF
  600 MM = NOR                                                          0610 TRF
      IF (THALDS(NT,NOR).GT.RMXDST) GO TO 304                           0620 TRF
      VELMU = RKA + RKB*THALDS(NT,MM)                                   0630 TRF
      GO TO 305                                                         0640 TRF
  304 VELMU = VELMUT                                                    0650 TRF
  306 CALL RANLOG(VELMU,VELSGT,TVELOG)                                  0660 TRF
      TRFVEL = 10.**TVELOG                                              0670 TRF
      IF(TRFVEL.GT.VELMIN) GO TO 401                                    0680 TRF
      TRFVEL = VELMIN                                                   0690 TRF
      GO TO 307                                                         0700 TRF
  401 IF(TRFVEL.LT.VELMAX)GO TO 307                                     0710 TRF
      TRFVEL = VELMAX                                                   0720 TRF
  307 TRFTMZ = (THALDS(NT,MM) /TRFVEL) * 60.                            0730 TRF
      TRFHR = TRFHR + TRFTMZ                                            0740 TRF
      RND = RNNP(0)                                                     0750 TRF
      FLATNO = PRBFLT * THALDS(NT,MM)                                   0760 TRF
      IF (RND.GT.FLATNO) GO TO 310                                      0770 TRF
      ORHR = ORHR + FLTLTM                                              0780 TRF
      TIME(NT) = TIME(NT) + TRFTMZ + FLTLTM                             0790 TRF
      TRCSIN = TRCSIN + 1.                                              0800 TRF
      GO TO 314                                                         0810 TRF
  310 TIME(NT) = TIME(NT) + TRFTMZ                                      0820 TRF
  314 IF(EVENT(NT).GT.1.) GO TO 318                                     0830 TRF
      EVENT(NT) = 2.                                                    0840 TRF
      GO TO 320                                                         0850 TRF
  318 EVENT(NT) = 4.                                                    0860 TRF
  320 STRFML = STRFML + THALDS(NT,MM)                                   0870 TRF
      RETURN                                                            0880 TRF
      END                                                               0890 TRF
                                                                        0900 TRF


$IBFTC UNPA*
      SUBROUTINE UNPACK(IWORD,I1,I2)                                    0010 UNP
C                                                                       0020 UNP
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0030 UNP
C                                                                       0040 UNP
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0050 UNP
      COMMON IFRST4,IFRSTA,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0060 UNP
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0070 UNP
      DIMENSION ICORE(1000), CORE(50)                                   0080 UNP
      EQUIVALENCE(ICORE,CORE)                                           0090 UNP
C                                                                       0100 UNP
C     COMMON AND DIMENSION FOR SIMULATION                               0110 UNP
C                                                                       0120 UNP
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0130 UNP
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0140 UNP
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0150 UNP
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0160 UNP
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DELDEP,DMTAVE,     0170 UNP
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0180 UNP
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0190 UNP
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,             0200 UNP
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0210 UNP
     9            HISC42,HISC43,HISC44                                  0220 UNP
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                   0230 UNP
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0240 UNP
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0250 UNP
     3            KINTRL,KSTMFS,KTMOP,MAXLQ,NA,NAREA,NC,NDA,            0260 UNP
     4            NOR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0270 UNP
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0280 UNP
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0290 UNP
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0300 UNP
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0310 UNP
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0320 UNP
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,           0330 UNF
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0340 UNP
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,              0350 UNP
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0360 UNP
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0370 UNP
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,             0380 UNP
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0390 UNP
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0400 UNP
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,              0410 UNP
     9            WATEZ,WT,XDAY,YRS                                     0420 UNP
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0430 UNP
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,           0440 UNP
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,           0450 UNP
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0460 UNP
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0470 UNP
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0480 UNP
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),           0490 UNP
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0500 UNP
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,           0510 UNP
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0520 UNP
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) , 0530 UNP
     1           TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,            0540 UNP
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0550 UNP
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0560 UNP
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0570 UNP
                                                                        0580 UNP
```

```
C
      IF(ICHECK) 4,2,3
    1 FORMAT(///1X,12HAT ICLOCK = ,I8,13HAND JCHECK = ,I8/1X,
     X22HERROR CONDITION NUMBER,I8,13H WAS IGNORED.)
    3 WRITE (IOU,1) ICLOCK,JCHECK,ICHECK
      CALL PANIC
    4 ICHECK=0
    2 I1=IWORD/MAXINT
      I2=IWORD-I1*MAXINT
      RETURN
      END


$IBFTC WKSM*
      SUBROUTINE WEEKSM
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXI,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLEHE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,
     4            CREWTS,CRUSZ,CSHRIC,CSTHP,CTS,DAYS,DELDEP,DMTAVE,
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DROPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JOW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSTMFS,KTMOP,MAXLQ,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGML,STAT,STMEST,STREML,SUMRUT,SUMTRK,
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TREHR,TREML,TRETMZ,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMOR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATEZ,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)   ,AX2(25)   ,
     2           AY1(25)   ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)    ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)  ,OVRTM(50) ,PERUN(4)  ,QQ(50)    ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)  ,TONAGE(6) ,TOTWT(50) ,TRC(60)   ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)   ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
      SRIGML = TRPRIG * TRLHAL * 2.0
C
      DO 10 I=1,6
      COSCOL = COSCOL + CCL(I)
      TSCOST = TSCOST + CTS(I)
      TOTTON = TOTTON + TONAGE(I)
   10 CONTINUE
C
      TOTCOS = COSCOL + TSCOST
      DOLCOL = COSCOL/TOTTON
      DOLRIG = TSCOST/TOTTON
      DOLTON = TOTCOS/TOTTON
      CALL STAC(1,K2,TSTM,DMTAVE,DMTSIG,DMTMAX,DMTMIN)
      CALL STAC(1,K4,QUT2,QUIAVE,QUISIG,QUIMAX,QUIMIN)
      SUMACT = COLHR + TREHR + TSHR + ORHR
      COLHR = (COLHR / SUMACT) * 100.
      TREHR = (TREHR / SUMACT) * 100.
      TSHR = (TSHR / SUMACT) * 100.
      ERRR = (ERRR / SUMACT) * 100.                                     0790 WKS
C                                                                       0800 WKS
      DO 100 J = 1,12                                                   0810 WKS
      Q1 = Q1 + TIMEQ(1,J)                                              0820 WKS
  100 CONTINUE                                                          0830 WKS
C                                                                       0840 WKS
      DO 200 J = 1,12                                                   0850 WKS
      Q2 = Q2 + TIMEQ(2,J)                                              0860 WKS
  200 CONTINUE                                                          0870 WKS
C                                                                       0880 WKS
      DO 300 J = 1,12                                                   0890 WKS
      TIMEQ(1,J) = TIMEQ(1,J) * 100. / (Q1 + 0.5)                       0900 WKS
  300 CONTINUE                                                          0910 WKS
C                                                                       0920 WKS
      DO 400 J = 1,12                                                   0930 WKS
      TIMEQ(2,J) = TIMEQ(2,J) * 100. / (Q2 + 0.5)                       0940 WKS
  400 CONTINUE                                                          0950 WKS
C                                                                       0960 WKS
      DO 121 I = 71,90                                                  0970 WKS
      IF (TRIP(I).EQ.0.) GO TO 122                                      0980 WKS
  121 CONTINUE                                                          0990 WKS
C                                                                       1000 WKS
  122 NOTRL = I - 71                                                    1010 WKS
      RETURN                                                            1020 WKS
      END                                                               1030 WKS


$IBFTC XINI*                                                            0010 XIN
      SUBROUTINE XINIT                                                  0020 XIN
C                                                                       0030 XIN
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES                 0040 XIN
C                                                                       0050 XIN
      COMMON IBUG,ICALDR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2       0060 XIN
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK      0070 XIN
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1                                  0080 XIN
      DIMENSION ICORE(1000), CORE(50)                                   0090 XIN
      EQUIVALENCE(ICORE,CORE)                                           0100 XIN
C                                                                       0110 XIN
C                                                                       0120 XIN
C     COMMON AND DIMENSION FOR SIMULATION                               0130 XIN
C                                                                       0140 XIN
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,           0150 XIN
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,     0160 XIN
     2            COLFRE,COLHR,COLMLK,COLTMZ,COMPAP,CONA,CONB,          0170 XIN
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,             0180 XIN
     4            CREWTS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DFLDEP,DMTAVE,     0190 XIN
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,            0200 XIN
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,             0210 XIN
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,             0220 XIN
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,            0230 XIN
     9            HISC42,HISC43,HISC44                                  0240 XIN
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,                   0250 XIN
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,           0260 XIN
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,           0270 XIN
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,            0280 XIN
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,               0290 XIN
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCE,OPTM,              0300 XIN
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,          0310 XIN
     7            PRBFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,             0320 XIN
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,              0330 XIN
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA              0340 XIN
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,           0350 XIN
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,         0360 XIN
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,              0370 XIN
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,                0380 XIN
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,           0390 XIN
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,             0400 XIN
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,               0410 XIN
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,               0420 XIN
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,              0430 XIN
     9            WATEZ,WT,XDAY,YRS                                     0440 XIN
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),           0450 XIN
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,         0460 XIN
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,          0470 XIN
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),          0480 XIN
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),           0490 XIN
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),           0500 XIN
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),           0510 XIN
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),           0520 XIN
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)     ,        0530 XIN
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)              0540 XIN
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) , 0550 XIN
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,           0560 XIN
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),       0570 XIN
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),        0580 XIN
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)                0590 XIN
C                                                                       0600 XIN
      MAXT = 1000                                                       0610 XIN
      MAXINT = 100000                                                   0620 XIN
      ICHECK=0                                                          0630 XIN
      JCHECK=0                                                          0640 XIN
      IFRST8=0
      IFRST4=0
      IFRST2=0
      ICORE(1)=0
      ICORE(2)=0
      ICORE(3)=C
      MAXCRE = 1000
      IOVRHD=4
      ICALOR=0
      ICORE(4)=IOVRHD
      IDUMM2=-123456
      IDUMM4=-234567
      J=IOVRHD+1
C
      DO 105 I=J,MAXCRE
  105 ICORE(I)=0
C
      J=MAXCRE-8
C
      DO 104 I=IOVRHD,J,8
  104 CALL FILAST(I,8,IFRST8)
C
      RETURN
      END



$IBFTC ZERI.
      SUBROUTINE ZERINT
C
C     COMMON AND DIMENSION FOR LIST PROCESSING ROUTINES
C
      COMMON IBUG,ICALOR,ICHECK,ICLOCK,ICORE,IDUMM2,IDUMM4,IFRST2
      COMMON IFRST4,IFRST8,IOVRHD,ITIME1,ITIME2,ITYPE2,JBUG,JCHECK
      COMMON MAXCRE,MAXINT,MAXT,ITYPE1
      DIMENSION ICORE(1000), CORE(50)
      EQUIVALENCE(ICORE,CORE)
C
C
C     COMMON AND DIMENSION FOR SIMULATION
C
      COMMON /BD/ A9,ACRE,AHALDS,ANETYP,ANOHUN,ANORUT,ASNUPT,
     1            AASSUN,ASSSUN,ASSUNK,AX1,AX2,AY1,AY2,B,CCL,CLKTM,
     2            COLFRF,COLHR,COLMLK,COLTM2,COMPAP,CONA,CONB,
     3            CONC,COND,CONE,CONF,COSCOL,CORACR,COSLND,
     4            CREWIS,CRUSZ,CSHRTC,CSTHR,CTS,DAYS,DFLDEP,DMTAVE,
     5            DMTMAX,DMTMIN,DMTSIG,DOLCOL,DOLRIG,DOLTON,
     6            DOLTS,DRDPAY,DROVRT,DSLC,DW,EVENT,FINDAY,
     7            FLATNO,FLTLTM,FX,FY,HISC12,HISC13,HISC14,
     8            HISC22,HISC23,HISC24,HISC32,HISC33,HISC34,
     9            HISC42,HISC43,HISC44
      COMMON /BD/ HISTD1,HISTU1,HISTU2,HISTU3,HISTU4,
     1            ICOLFR,IN,INCRMT,IOU,IRUNNO,ITIML,JDW,JTRC,
     2            JTRL,JTRPCL,JTRPRG,K,K2,K4,K5,KAPTS,KINTRK,
     3            KINTRL,KSTMFS,KTMDP,MAXLQ,NA,NAREA,NC,NDA,
     4            NDR,NN,NORUT,NOFLTS,NOTRC,NOTRC2,NOTRK,
     5            NOTRL,NOVRT1,NOVRT2,NOVRT3,NT,ONCF,OPTM,
     6            ORHR,OVPAYL,OVRTM,PAYLBR,PERUN,PNDMU,PNDSIG,
     7            PRHFLT,Q0,Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,
     8            Q11,QMAX,QQ,QUIAVE,QUIMAX,QUIMIN,QUISIG,
     9            QUITMC,QUITTM,QUT2,R,RGVMAX,RGVMIN,RIGKA
      COMMON /BD/ RIGKB,RIGMAX,RIGVEL,RKA,RKAA,RKB,RKBB,RKCC,
     1            ROADIS,RMXDSR,RMXDST,RND,RUNNO,SCOLML,SMWRKT,
     2            SRIGML,STAT,STMFST,STRFML,SUMRUT,SUMTRK,
     3            TAREA,THALDS,TIME,TIMEQ,TNETYP,TNOHUN,
     4            TONAGE,TOTCOS,TOTTON,TOTWT,TRC,TRCSIN,TRES,
     5            TRFHR,TRFML,TRFTMZ,TRIP,TRKDAY,TRKLD,TRL,
     6            TRLHAL,TRPCOL,TRPRIG,TRPTM,TSCOST,TSHR,
     7            TSLBPA,TSTM,TX,TY,UNACRE,UTILTY,VELMAX,
     8            VELMIN,VELMUR,VELMUT,VELSGR,VELSGT,WATE,
     9            WATEZ,WT,XDAY,YRS
      DIMENSION  AHALDS(25),ANETYP(25),ANOHUN(25),ANORUT(25),
     1           ASNUPT(25),AASSUN(25),AX1(25)    ,AX2(25)    ,
     2           AY1(25)    ,AY2(25), B(10),CCL(6),COLMLK(4) ,
     3           CORACR(4) ,CTS(6)     ,EVENT(60) ,HISC12(16),
     4           HISC13(16),HISC14(16),HISC22(16),HISC23(16),
     5           HISC24(16),HISC32(16),HISC33(16),HISC34(16),
     6           HISC42(16),HISC43(16),HISC44(16),HISTD1(16),
     7           HISTU1(16),HISTU2(16),HISTU3(16),HISTU4(16),
     8           OPTM(60)   ,OVRTM(50) ,PERUN(4)   ,QQ(50)      ,
     9            QUITMC(60),QUT2(300),ROADIS(25),STAT(90)
      DIMENSION  TIME(60)   ,TONAGE(6) ,TOTWT(50) ,TRC(60)    ,TRIP(90) ,
     1           TRKLD(50) ,TRL(60)    ,TSTM(1000),WATE(50) ,
     2           DAYS(2,3), ITIML(2,12), QUITTM(50,6), RKAA(4,2),
     3           RKBB(4,2),  RKCC(4,2),TAREA(50,3),THALDS(50,3),
     4           TIMEQ(2,12), TNETYP(50,3), TNOHUN(50,3)
C
      DO 29 I = 1,90
      STAT(I) = 0.
      TRIP (I) = 0
   29 CONTINUE
C
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      DO 800 I = 1,10                                                   0660 ZER
      B(I) = 0                                                          0670 ZER
  800 CONTINUE                                                          0680 ZER
C                                                                       0690 ZER
      DO 771 I = 51,NOTRC2                                              0700 ZER
      STAT(I) = 8                                                       0710 ZER
  771 CONTINUE                                                          0720 ZER
C                                                                       0730 ZER
      DO 772 I = 72,90                                                  0740 ZER
      STAT(I) = 10                                                      0750 ZER
  772 CONTINUE                                                          0760 ZER
C                                                                       0770 ZER
      DO 111 I = 1,6                                                    0780 ZER
      CC(I) = 0                                                         0790 ZER
      CTS(I) = 0                                                        0800 ZER
      TCNAGE(I) = 0                                                     0810 ZER
  111 CONTINUE                                                          0820 ZER
C                                                                       0830 ZER
      DO 122 I = 1,1000                                                 0840 ZER
      ISTM(I) = 0                                                       0850 ZER
  122 CONTINUE                                                          0860 ZER
C                                                                       0870 ZER
      DO  159 I = 1,2                                                   0880 ZER
      DO 160 J = 1,12                                                   0890 ZER
      TIMEQ(I,J)=0.                                                     0900 ZER
  160 CONTINUE                                                          0910 ZER
  159 CONTINUE                                                          0920 ZER
C                                                                       0930 ZER
      DO 100 I = 1,NAREA                                                0940 ZER
      ASNUPT(I) = 0.                                                    0950 ZER
      AFALDS(I) = 0.                                                    0960 ZER
      AASSUN(I) = 0.                                                    0970 ZER
      ANCRUT(I) = 0.                                                    0980 ZER
  100 CONTINUE                                                          0990 ZER
C                                                                       1000 ZER
      COLHR = 0                                                         1010 ZER
      CCSCOL = 0.                                                       1020 ZER
      DMTAVE = 0.                                                       1030 ZER
      DMTMAX = 0.                                                       1040 ZER
      DMTMIN = 0.                                                       1050 ZER
      DMTSIG = 0.                                                       1060 ZER
      DOLCOL = 0.                                                       1070 ZER
      DOLRIG = 0.                                                       1080 ZER
      DOLTON = 0.                                                       1090 ZER
      K2 = 0                                                            1100 ZER
      K4 = 0                                                            1110 ZER
      K5 = 0.                                                           1120 ZER
      MAXLQ = 0                                                         1130 ZER
      NC = 0                                                            1140 ZER
      NN = 0                                                            1150 ZER
      NOFLTS = 0.                                                       1160 ZER
      NOTRK  = 0.                                                       1170 ZER
      NOVRT1 = 0.                                                       1180 ZER
      NOVRT2 = 0.                                                       1190 ZER
      NOVRT3 = 0.                                                       1200 ZER
      ORHR = 0                                                          1210 ZER
      Q0 = 0                                                            1220 ZER
      Q1 = 0                                                            1230 ZER
      Q2 = 0                                                            1240 ZER
      QTM = 0                                                           1250 ZER
      QUIAVE = 0.                                                       1260 ZER
      QUIMAX = 0.                                                       1270 ZER
      QUIMIN = 0.                                                       1280 ZER
      QUISIG = 0.                                                       1290 ZER
      SCOLML = 0.                                                       1300 ZER
      SMWRKT = 0                                                        1310 ZER
      SRIGML = 0.                                                       1320 ZER
      STAT(71) = 13                                                     1330 ZER
      STRFML = 0.                                                       1340 ZER
      SUMRUT = 0.                                                       1350 ZER
      TOTCOS = 0.                                                       1360 ZER
      TOTTON = 0.                                                       1370 ZER
      TRCSIN = 0                                                        1380 ZER
      TREHR = 0                                                         1390 ZER
      TRKDAY = 0.                                                       1400 ZER
      TRPCOL = 0.                                                       1410 ZER
      TRPRIG = 0.                                                       1420 ZER
      TSCOST = 0.                                                       1430 ZER
      TSHR = 0                                                          1440 ZER
      TTT = 0                                                           1450 ZER
      TTT2 = 0                                                          1460 ZER
      X = 0                                                             1470 ZER
      X13 = 0.                                                          1480 ZER
      Y = 0                                                             1490 ZER
      ICOLFR = COLFRE                                                   1500 ZER
      IRUNNO = RUNNO                                                    1510 ZER
C                                                                       1520 ZER
      DO 137 I = 1,300                                                  1530 ZER
      QUT2(I) = 0                                                       1540 ZER
  137 CONTINUE                                                          1550 ZER
C                                                                       1560 ZER
      DO 55 I = 1,50                                                    1570 ZER
      DO 56 J = 1,6                                                     1580 ZER
      QUITTM(I,J) = 0.                                                  1590 ZER
   56 CONTINUE                                                          1600 ZER
   55 CONTINUE                                                          1610 ZER
C                                                                       1620 ZER
      DO 200 I = 1,50                                                   1630 ZER
      DO 300 J = 1,3                                                    1640 ZER
      TAREA (I,J) = 0.                                                  1650 ZER
      TNOHUN(I,J) = 0.                                                  1660 ZER
      THALDS(I,J) = 0.                                                  1670 ZER
      TNFTYP(I,J) = 0.                                                  1680 ZER
  300 CONTINUE                                                          1690 ZER
  200 CONTINUE                                                          1700 ZER
C                                                                       1710 ZER
      RETURN                                                            1720 ZER
      END                                                               1730 ZER
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